

Geophysical Abstracts 170 July-September 1957

GEOLOGICAL SURVEY BULLETIN 1066-C



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By MARY C. RABBITT, DOROTHY B. VITALIANO, S. T. VESSELOWSKY, and others

G E O L O G I C A L S U R V E Y B U L L E T I N 1 0 6 6 - C

*Abstracts of current literature pertaining
to the physics of the solid earth and to
geophysical exploration*



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GEOPHYSICAL ABSTRACTS 170, JULY-SEPTEMBER 1955

By MARY C. RABBITT, DOROTHY B. VITALIANO, S. T. VESSELOWSKY
and others

INTRODUCTION

EXTENT OF COVERAGE

Geophysical Abstracts includes abstracts of technical papers and books on the physics of the solid earth, the application of physical methods and techniques to geologic problems, and geophysical exploration. The table of contents, which is alphabetically arranged, shows the material covered.

Abstracts are prepared only of material that is believed to be generally available. Ordinarily abstracts are not published of material with limited circulation (such as dissertations, open-file reports, or memoranda) or of other papers presented orally at meetings unless summaries of substantial length are published. Abstracts of papers in Japanese and Chinese are based on abstracts or summaries in a western language accompanying the paper.

LIST OF JOURNALS

Full titles and abbreviations of journals cited for the first time in this issue (with the sponsoring organization and its address where these do not form part of the title) are given below. This list supplements the List of Journals published in Geophysical Abstracts 160 (January-March 1955, Bulletin 1033-A) and the supplements published in Geophysical Abstracts 161-169.

Acad. Polonaise Sci. Bull.—Bulletin de l'Académie Polonoise des Sciences.
Polska Akademiya Nauk, Warsaw.

Appl. Sci. Research—Applied Scientific Research. Published under the auspices of the Central National Council for Applied Scientific Research in the Netherlands, The Netherlands Physical Society, The Royal Institute of Engineers, The Mathematical Centre. The Hague.

Bur. central séismol. internat. Pubs., sér. A, Travaux sci.—Publications du Bureau Central Séismologique International. Association de Séismologie et de Physique de l'Intérieur de la Terre. Toulouse, France.

Chroniques des Mines d'Outre-Mer—La Chronique des Mines d'Outre-Mer et de la Recherche Minière. Bureau d'Études géologiques et minières, Paris.

- Danmarks Geol. Undersøgelse—Danmarks Geologiske Undersøgelse. København.
 Doshisha Kogaku Kaishi—The Engineering Association in Doshisha University.
 Kyoto, Japan.
- Edinburgh Geol. Soc. Trans.—Transactions of the Edinburgh Geological Society.
- French West Africa Direction federale Mines et Géologie Bull.—Bulletin de la
 Direction federale des Mines et de la Géologie. Gouvernement general de
 l'Afrique Occidentale Française. Dakar.
- Queensland Univ. Dept. Geology Papers—University of Queensland Papers,
 Department of Geology. Brisbane.
- Rev. Géographie phys. et Géologie dynamique—Revue de géographie physique
 et de géologie dynamique. L'Association des Amies et anciens Élèves du
 Laboratoire de géographie physique et de géologie dynamique de la Faculté
 des Sciences de Paris.
- Saskatchewan Dept. Mineral Resources Rept.—Report of the Department of
 Mineral Resources of the Province of Saskatchewan. Regina.
- Soc. mineralog. Italiana Rend.—Rendiconto della Società Mineralogica Italiana.
 Pavia.
- Soc. Royale Sciences Liège Bull.—Bulletin de la Société Royale des Sciences
 de Liège.
- Vses. nauchno-issled. inst. razved. geofiz. Voprosy rudnoy geofiz.—Vsesoyuznyy
 nauchno-issledovatel'skiy institut razvedochnoy geofiziki, Voprosy rudnoy
 geofiziki. Moskva.

FORM OF CITATION

The abbreviations of journal titles used are those adopted by the U. S. Geological Survey and used in many geological journals. For papers in most languages other than English, the title is given in the original language as well as in translation. Slavic names and titles have been transliterated by the system used by the United States Board on Geographic Names. This system of transliteration for Russian was given in Geophysical Abstracts 148 (January-March 1952, Bulletin 991-A). Titles of papers in Japanese and Chinese are given in translation only.

ABSTRACTORS

Abstracts in this issue have been prepared by Beryl T. Everett, J. R. Balsley, W. J. Dempsey, R. G. Henderson, M. F. Kane, Virginia S. Neuschel, L. C. Pakiser, and L. Peselnick, as well as by the principal authors. The notation "Author's abstract" followed by the initials of an abstractor indicates a translation of the author's abstract.

AGE DETERMINATIONS

- 170-1. Holmes, Arthur. How old is the earth?: Edinburgh Geol. Soc. Trans.,
 v. 16, pt. 3, p. 313-333, 1956.

The advances made during the last decade in estimating the time that has elapsed since the original material of the earth became differentiated into crust, mantle, and core are briefly reviewed. The earlier estimates (3,300-3,500 mil-

lion years) based on the isotopic compositions of lead from galenas of known age are now replaced by one of about 4,500 million years, as a result of the steadily increasing wealth of available data. Patterson and his co-workers have found that the proportions of lead isotopes (to lead-204) in lead from iron meteorites are lower than those in lead from any other known source. Adopting such lead as primeval, Patterson finds that both meteorites and the earth have essentially the same age, $4,500 \pm 70$ million years. Using a series of leads ranging in age from the present to over 2,900 million years ago, I find $4,500 \pm 100$ million years from the time primary differentiation. Using only Palaeozoic and younger leads, Russell and Allan reach an estimate of $4,300 \pm 400$ million years. Possible differences between meteorites and the earth in age and primeval-lead composition are discussed, and reasons are given for thinking that the sialic crust seems to be a more likely source of lead ores than the ultrabasic material of the underlying mantle.—*Author's abstract*

- 170-2. Prider, Rex T. The Pre-Cambrian succession in Western Australia : Pan Indian Ocean Sci. Cong., 2d, Proc., Sec. C—Geology, p. 69-76, 1954.

A discussion of the Precambrian succession in the Western Australian part of the Australian Shield includes a review of all age determinations by radioactive methods made to date.—*V. S. N.*

- 170-3. Krishnan, R. S. Age determination of crustal rocks by radioactivity methods : Geological Time, Council of Sci. and Indus. Research [India], Comm. on Measurement of Geol. Time in India, p. 12-16, 1954.

A discussion of the uranium-thorium, alpha helium and radium-thorium, radium-thorium-helium, and rubidium-strontium methods for determination of geological time.—*V. S. N.*

- 170-4. Vinogradov, A. P. Sravneniye dannykh po vozrastu porod, poluchennykh razlichnymi metodami, i geologicheskoye vyvody [Comparison of data on the age of rocks obtained by different methods, and geological conclusions] : Geokhimiya, no. 5, p. 3-17, 1956.

All available age determinations on the different igneous complexes comprising the Precambrian Ukrainian massif are compiled in elaborate tables. The determinations were made by different investigators (Vinogradov, Komlev, Starik) on different minerals (biotite, allanite, monazite, sphene, malacon, and zircon) using different methods (K^{40}/A^{40} , Rb^{87}/Sr^{87} , and lead isotope ratios). In some cases more than one mineral and more than one method were used for the same rock. Discrepancies in some of the results are caused at least in part by use of different values for the radioactive constants by different workers. Determinations using monazite are considered to be most reliable.

From critical analysis of the assembled data, it is concluded that the Umansko-Novomirgorodskiy granites are probably 1130 to 1400 million years old; that the Dneprovsko-Tokovskiy, Kirovogradsko-Zhitomirskiy, and Chudново-Berdichevskiy complexes belong to the same geologic epoch, 1800-2000 million years old (establishment of the contemporaneity of these three complexes is regarded as the most important conclusion drawn from this investigation); from its relation to the Kirovogradsko-Zhitomirskiy complex, the Krivorozhskaya series must be about 1900 million years old; the Priazovskiy alkaline complex (1800-1920 million years) is also contemporaneous with the Kirovogradskiy granites. These ancient rocks do not represent the oldest Precambrian platforms of the

earth, but indicate intense volcanic activity during the Keewatin and other orogenies in upper and lower Archean time.—S. T. V., D. B. V.

- 170-5. Webster, R. K., Morgan, J. W., and Smales, A. A. Some recent Harwell analytical work on geochronology: *Am. Geophys. Union Trans.*, v. 38, no. 4, p. 543-546, 1957.

Ages of the Forest City and Johnstown meteorites have been determined by the rubidium-strontium method as $4.6 \pm 0.5 \times 10^9$ years. Four lepidolites ranging in age from 100 to 2,600 million years were also studied. Rubidium contents determined by stable isotope dilution are in good agreement with those obtained by neutron activation analysis. By a new direct polarographic method, lead concentrations of the order of 0.2 percent may be determined with a precision of 2 or 3 percent in samples as small as 10 mg.—M. C. R.

- 170-6. Patterson, R. L., Jr., and Blifford, I. H., Jr. Atmospheric carbon-14: *Science*, v. 126, no. 3262, p. 26-28, 1957.

Because of the importance of C^{14} in dating techniques a study was made of atmospheric C^{14} and the additions of this material from thermonuclear explosions. It was assumed that any C^{14} formed in nuclear tests would be present in the air as CO_2 and collections of this gas were begun in 1952. The Suess counting technique (*Geophys. Abs.* 158-172) was used. All measurements were compared with standard counts from strontium carbonate prepared from fossil carbon and from contemporary carbon which had been previously measured. In collections made from October to December 1952 in French Morocco, Alaska, Washington, D. C., the Hawaiian Islands and the Philippine Islands, the C^{14} content of the atmosphere did not exceed that of the standard. Collections made at Subic Bay, Philippine Islands, after the thermonuclear tests of 1954, show that the concentration of C^{14} was higher than in the 1952 tests. Collections made in Washington, D. C. from January 1955 to February 1956 show higher values than those of 1952. The increase of C^{14} content of atmospheric CO_2 from 1952 to 1956 is thought to be the result of additions from thermonuclear sources and the delayed increase of C^{14} at ground level may indicate a stratospheric reservoir of this isotope.—V. S. N.

- 170-7. de Vries, Hl. Contribution of radiocarbon dating and measurement of paleotemperatures to Pleistocene correlations: *Geologie en Mijnbouw*, 19^e jaarg., no. 7, p. 303-304, 1957.

The importance of carbon-14 dating for Pleistocene correlations is obvious; indirectly, the better understanding thus obtained of Pleistocene time should also lead to more reliable analysis of older glaciations. Paleotemperature measurements by the $\delta^{18}O/\delta^{16}O$ ratio show the main climatic oscillations recorded in deep sea cores (a record not affected by the difficulty that a new glaciation tends to erase remnants of previous glaciations); these major fluctuations should be correlatable with the major glacial and interglacial epochs.—D. B. V.

- 170-8. Stearns, Charles E. Evidence for strand lines 4 m and 2 m above sea level at Tangier, Morocco, and Tipasa, Algeria: *Quaternaria*, v. 3, p. 173-178, 1956.

By inference from radiocarbon dates of Neolithic artifacts, the youngest strand line at two areas along the North African coast, 1 to 2 m above the present, was formed some time between 4,000 B. C. and the beginning of the Christian

era. Another level 4 m below the present may represent an earlier and perhaps longer stillstand, rather than modern erosion as commonly assumed.—*D. B. V.*

- 170-9. Gill, Edmund D. Radiocarbon dating of late Quaternary shorelines in Australia: *Quaternaria*, v. 3, p. 133-138, 1956.

Radiocarbon dating of former stillstands of the sea can solve the problem of their distribution in time, allow intercontinental correlations, and, where there have been tectonic movements, distinguish eustatic from tectonic changes. The first radiocarbon dates of eustatic levels for Australia are as follows: the higher ("25-ft sea") level, more than 35,000 years or Sangamon; the lower sea-level of the last glaciation (at least 73 ft below present sea level), almost 9,000 years ago or Mankato; the post-glacial higher level (Flandrian), about 5,000 years ago; and a pre-Mankato interglacial 10-ft higher sea level, "older than 30,000 years" (See also *Geophys. Abs.* 168-9).—*D. B. V.*

- 170-10. Münnich, K. O. Heidelberg natural radiocarbon measurements 1: *Science*, v. 126, no. 3266, p. 194-199, 1957.

Carbon-14 age determinations made at the University of Heidelberg between March 1954 and July 1956 are tabulated. Proportional counting of carbon dioxide with a gas pressure of roughly 1 atmosphere was used in making the measurements. Samples included wood dated by dendrochronology, modern plants (to study the effect of industrial combustion of coal and oil on the specific carbon-14 activity), and material dated archeologically or by pollen analysis.—*M. C. R.*

- 170-11. Fergusson, G. J., and Rafter, T. A. New Zealand ^{14}C age measurements—3: *New Zealand Jour. Sci. Technology*, sec. B, v. 38, no. 7, p. 732-749, 1957.

A list of 40 new radiocarbon dates from the Dominion Physical Laboratory in Wellington, measured during the period May 1955-May 1956.—*D. B. V.*

- 170-12. Fergusson, G. J., and McCallum, G. J. The cosmic ray flare of 23 February 1956 and its effect on the New Zealand radiocarbon dating equipment: *New Zealand Jour. Sci. Technology*, sec. B, v. 38, no. 6, p. 577-587, 1957.

Observation of a large increase in background counting rate of the New Zealand radiocarbon dating equipment during the solar flare of 23 February 1956 has shown that ≈ 60 percent of the background is due to the nucleonic component of cosmic rays. The pulse height distribution of the increase shows the detection of fast neutrons is the main process by which the equipment detects the nucleonic component. Variations in background which occur due to fluctuations in the intensity of the primary particles producing the nucleonic component can be corrected by simultaneous monitoring of the intensity of the nucleonic component. This is essential if the theoretical accuracy of the equipment is to be achieved experimentally.—*Authors' conclusions*

- 170-13. Fleming, C. A. The ages of some Quaternary sediments from Wanganui district (N 137, N 138): *New Zealand Jour. Sci. Technology*, sec. B, v. 38, no. 7, p. 726-731, 1957.

The sequence and correlation of late Pleistocene-Holocene formations in Wanganui district, New Zealand, are discussed in the light of four previously

published radiocarbon dates (see Geophys. Abs. 157-139 and 161-34). The coastal plain formations of the type Hawera Series are older than 45,000 years, thus older than the later substages of the last glaciation. An important shower of pumice lapilli was erupted into the headwaters of Wanganui River $2,300 \pm 170$ years ago, or about 250 B. C. A submerged forest at Waitotara River is dated as $1,020 \pm 60$ years old, confirming the subsidence as recent. This forest is much younger than the Titahi Bay forest ($>35,000$ years old).—D. B. V.

- 170-14. Pantin, H. M. Fossiliferous concretions from the shelf south-east of Cape Campbell, New Zealand: New Zealand Jour. Sci. Technology, sec. B, v. 38, no. 7, p. 781-791, 1957.

Carbon-14 dating of a fossiliferous calcareous concretion dredged up off the New Zealand coast southeast of Cape Campbell gives an age of $19,500 \pm 1,000$ years for the shells and $27,500 \pm 3,000$ years for the matrix. The fauna indicates a colder climate than today. The matrix cannot represent a direct precipitation from the sea but must be derived from sediments at least 8,000 years older than the fauna.—D. B. V.

- 170-15. Nydal, R., and Sigmond, R. S. Radiocarbon dating in Trondheim: Appl. Sci. Research, Sec. B, v. 6, p. 393-400, 1956.

Naturally occurring radiocarbon is registered in a proportional counter filled with pure CO_2 . The CO_2 gas is purified in almost the same manner as has been developed by De Vries and Barendsen. Checking of the gas purity is described. A grid proportional counter with an effective volume of about 2.5 liter has been used with CO_2 -pressures from 1 to 4 atmospheres. At a pressure of 4 atmospheres the net count from contemporary wood is 58 counts per min above a background of 15 counts per min. Dating may at the present stage be extended to 35,000 years by 24 hours counting with 4 atmospheres CO_2 . A method for checking the discriminating level of the apparatus is described.—*Authors' summary*

- 170-16. Ostlund, H. G. Stockholm natural radiocarbon measurements 1: Science, v. 126, no. 3272, p. 493-497, 1957.

Carbon-14 age determinations at the Stockholm laboratory from early 1955 until May 12, 1957 are tabulated. The black-carbon method with the double screen-wall counter of the type developed in Copenhagen was first used but was replaced early in 1956 by the carbon dioxide proportional counting apparatus now used. Samples listed include industrial material, submorainic samples, material from the bed of the Baltic Sea, and from peat bogs and archeological sites.—M. C. R.

- 170-17. Dreimanis, Aleksis. Stratigraphy of the Wisconsin glacial stage along the northwestern shore of Lake Erie: Science, v. 126, no. 3265, p. 166-168, 1957.

Six-year field investigations and laboratory studies, including carbon-14 dating, have provided information sufficient for preliminary conclusions on the Wisconsin stratigraphy of the area north of Lake Erie. Four glacial stages are indicated. Carbon-14 ages of the first interstadial range from $>25,000$ to $>39,000$ years; the second interglacial interval was 24,600-28,200 years ago; the age of the main Wisconsin glaciation is indicated as 12,660 years.—M. C. R.

- 170-18. Öpik, E. J. and Singer, S. F. Reinterpretation of the uranium-helium ages of iron meteorites: *Am. Geophys. Union Trans.*, v. 38, no. 4, p. 566-568, 1957.

Estimates of the ages of meteorites have been derived under the assumption that all the helium is produced by the decay of uranium and thorium, and that none of the helium has leaked out of the meteorite. However, a large part of the helium would be produced in the disintegration of iron nuclei by cosmic rays; more than 30 percent of such helium would be helium-3. Further the heating of iron meteorites in the collision process that creates them may produce physico-chemical effects that would tend to accelerate the outward diffusion of radiogenic helium.—*M. C. R.*

- 170-19. Begemann, F., Geiss, J[ohannes], and Hess, D. C. Radiation age of a meteorite from cosmic-ray-produced He^3 and H^3 : *Phys. Rev.*, v. 107, no. 2, p. 540-542, 1957.

At the time of fall (1948), the tritium activity of two different specimens of the Norton County meteorite were (0.28 ± 0.02) and (0.25 ± 0.02) disintegrations per minute per gram. The helium-3 contents were (2.27 ± 0.11) and $(2.35 \pm 0.11) \times 10^{-6}$ cc. Experiments indicate that there has been no appreciable loss of helium-3. The amount of helium-3 accumulated and the tritium production rate combined give apparent He^3 — H^3 ages for irradiation of 420 and 480 million years. The ages are reduced to 240 and 280 million years by making an assumption about the direct production of He^3 by spalling. The potassium-argon age of this meteorite is 4,400 (+640 or -740) million years. The difference may be the result of changes in cosmic radiation and that the present intensity has existed for not more than 500 million years, or, if cosmic radiation has not varied, that the He^3 — H^3 age defines the time at which the breakup of a much larger body produced this meteorite.—*M. C. R.*

- 170-20. Eckelmann, Walter R., and Kulp, J. Laurence. Uranium-lead method of age determination, Part II: North American localities: *Geol. Soc. America Bull.*, v. 68, no. 9, p. 1117-1140, 1957.

Many new isotopic age determinations by the uranium-lead method have been made on most of the important North American localities from which primary uranium minerals have been reported. With the aid of other published isotopic U-Pb age measurements the writers attempted to interpret the most probable age for each locality and to assign a reasonable uncertainty to that age. The recognition of differential lead loss, the relation of alteration to mineral type, the importance of radon leakage for young samples, and the potential analytical errors make it timely to conduct such a re-evaluation. Among the well-established ages are: Spruce Pine district, North Carolina, 360 ± 20 m. y.; Portland, Connecticut, 265 ± 10 m. y.; Front Range, Colorado, 59 ± 5 m. y.; Black Hills, South Dakota, 1620 ± 20 m. y.; southeast Manitoba, 2650 ± 100 m. y.; Lake Athabasca, Saskatchewan, 1900 ± 50 m. y.; and the Wilberforce area, 1050 ± 20 m. y. Other probable ages are Bedford, New York, 350 m. y.; Colorado Plateau, 60 m. y.; Coeur d'Alene, 1200 m. y.; and Great Bear Lake, Northwest Territories, 1500 m. y. Although there may have been several regional metamorphic events in the Appalachian Province in the Precambrian, the post-Cambrian effects appear at only two periods centering on 260 m. y. and 360 m. y. The Grenville metamorphism appears limited to a narrow time interval about 1050 m. y. ago. The

Front Range and Colorado Plateau uranium mineralization may have been one event occurring about 60 m. y. ago.—*Authors' abstract*

- 170-21. Russell, R. D., and Farquhar, R. M. Isotopic analyses of leads from Broken Hill, Australia [and] Hawley, J. E. Spectrographic analyses: *Am. Geophys. Union Trans.*, v. 38, no. 4, p. 557-565, 1957.

This paper presents the results of isotopic analyses of 25 leads extracted from galenas from Broken Hill, New South Wales, Australia, and analysed at the University of Toronto. Some of the galenas occurred in conformable ore deposits of the Broken Hill type and some occurred in weak, gently dipping fractures and are of the Thackaringa type. We interpret the isotopic analyses as indicating that the conformable ores are ordinary leads and the Thackaringa ores are anomalous leads, that the probable age of the ordinary leads is about $1,500 \pm 150$ million years, that the Thackaringa leads were derived from the conformable ores in a process that involved the addition of anomalous proportions of radiogenic lead from the country rocks, and that the addition of the anomalous radiogenic component occurred a few hundred million years after the time of formation of the conformable ores.

Qualitative spectrographic analyses of some of the ores were carried out at Queen's University, Ontario, and are included in the paper. Most significant is the fact that the anomalous leads are distinguishable from the ordinary leads on the basis of trace element content. The significance of the spectrochemical analyses is discussed.—*Authors' abstract*

- 170-22. Farquhar, R. M. and Russell, R. D. Anomalous leads from the upper Great Lakes region of Ontario: *Am. Geophys. Union Trans.*, v. 38, no. 4, p. 552-556, 1957.

Isotopic analyses of lead in 8 samples of galena from the Thunder Bay region indicate that significant additions of radiogenic lead were made before the galenas were deposited in their present locations. There seems to be a correlation between isotopic composition and distance from the Lake Superior shore. The leads nearer the shore have in general large radiogenic components. The data indicate the leads were deposited at about the same time, not more than $1,700 \pm 30$ million years ago.—*M. C. R.*

- 170-23. Tilton, G[eorge] R., Davis, G. L., Wetherill, G[eorge] W., and Aldrich, L. T. Isotopic ages of zircon from granites and pegmatites: *Am. Geophys. Union Trans.*, v. 38, no. 3, p. 360-371, 1957.

Isotopic lead age determinations have been made on 13 zircons obtained from rocks 185 to 1400 million years old. Concordant or nearly concordant ages are found for all the samples which contain no detectable common lead, and discordant ages are found for most, if not all, of the samples which contain common lead. A comparison is made between the concordant isotopic age patterns given by three zircons from the Grenville subprovince in Ontario and the discordant patterns given by three zircons from the Cordilleran region of western United States. This indicates that the discordant ages can be related to the recent orogenies which occurred in the Cordilleran region. The Grenville is a stable shield area. There is no relation between the agreement of the isotopic ages of zircon and crystal size, amount of radiation damage or optical appearance—that is, zoning, cloudiness, or inclusions.

When a discordant age result is compared with the potassium-argon and rubidium-strontium ages of associated mica the Pb^{207} - Pb^{206} age is found to be the closest to the mica age. Isotopic ages are compared with the simpler alpha-lead and chemical lead ages, which do not require isotopic analysis of lead. The non-isotopic ages are approximately correct for zircons which have concordant isotopic ages but are in error when discordant isotopic ages are found. No explanation is offered as to why the mica ages are apparently unaffected by the process or processes which altered the zircon ages. An understanding of this phenomenon would doubtless provide valuable information concerning the post-crystallization history of the samples.—*Authors' abstract*

- 170-24. Pangaud, Claudie, Lameyre, Jean, and Michel, Robert. Âge absolu des migmatites du Massif du Grand Paradis (Alpes franco-italiennes) [Absolute age of the migmatites of the Grand Paradis massif (Franco-Italian Alps)]: Acad. Sci. Paris, Comptes Rendus, tome 245, no. 3, p. 331-333, 1957.

The age of zircon inclusions abundant in the biotite of the migmatites from the Grand Paradis massif in the Alps, calculated by the lead-alpha method, is 340 million years. According to Holmes' time scale, this dates the migmatization of the crystalline schist series as Gothlandian (Silurian) and confirms the "pre-Carboniferous" age assigned on the basis of petrographic study.—*D. V. B.*

- 170-25. López de Azcona, [Juan] Manuel. La edad de las uraninitas de la Sierra Albarrana [The age of the uraninites of the Sierra Albarrana]: Inst. geol. min. España notas y comunicaciones, no. 45, p. 3-12, 1957.

The absolute age of uraninites from pegmatites in the Sierra Albarrana, Spain, based on lead isotope analyses, is slightly less than 280×10^6 yrs (Pb/U , 340×10^6 ; $206/238$, 350×10^6 ; $207/235$, 325×10^6 ; $207/206$, 280×10^6). The maximum Rb/Sr age determined on muscovite micas from the pegmatite zone is 280×10^6 yrs. These results corroborate Carbonell's dating, on structural grounds, of the mineralization as post-Westphalian, pre-Permian.—*D. B. V.*

- 170-26. Deutsch, Sarah. Âge des halos pléochroïques de la granite de Lausitz [Age of the Lausitz granite from the pleochroic haloes]: Experientia, v. 13, fasc. 8, p. 309-311, 1957.

Quantitative study of pleochroic haloes in biotite in the Lausitz granodiorite, in comparison to those from a granite from Elba known to be upper Eocene, indicates that the granite is about 280 ± 150 million years old and is, therefore, either Caledonian or Hercynian. This agrees with age determinations by other methods (see Geophys. Abs. 163-132 and 167-19).—*D. B. V.*

- 170-27. Carr, Donald R., and Kulp, J. Laurence. Potassium-argon method of geochronometry: Geol. Soc. America Bull., v. 68, no. 6, p. 763-784, 1957.

Experiments have demonstrated that the argon content of a rock can be released and measured with an accuracy of about 3 percent, and potassium analyses can be made with an accuracy of at least 3 percent for most samples. Both geologic and physical methods indicate that the branching ratio is about 0.12. Low branching ratios can be explained on the basis of incomplete retention of

argon within the sample. For minerals of known age the fraction of argon retained can be calculated; micas retain about 80-100 percent of their argon, but the retentivity of feldspars ranges from 40 to 85 percent.

Application of the potassium-argon method in the southern Appalachian region indicates two periods of metamorphism, the first about 550-570 million years ago and the second about 350 million years ago. In the Bear Mountain area of New York, potassium-argon ages indicate that the Storm King granite is 800 million years old and the Canada Hill gneiss about 1,400 million years old. Thus the Storm King granite can not be Paleozoic in age, and the New Jersey-New York Highlands may be older than the Blue Ridge Province of the southern Appalachian Mountains.—*M. C. R.*

- 170-28. Sardarov, S. S. Novyy reaktor dlya vydeleniya i ochistki radiogenogo argona [New reactor for separation and purification of radiogenic argon]: Akad. Nauk SSSR Izv. Ser. geol., no. 4, p. 108-112, 1957.

A brief description (with photograph and diagrammatic sketch) of the construction and operation of a new reactor for separating and purifying radiogenic argon for absolute age determinations is given. The new apparatus is almost twice as sensitive as the old because background count of atmospheric argon is decreased and partial pressure of the investigated argon is increased. Absorption of extraneous gases released with the radiogenic argon is greater. The time required for a single analysis is reduced 30 or 40 percent, to not more than 1.5 hours (in principle, the construction will allow 3 or 4 samples to be run simultaneously without admitting air, which would cut this time considerably).—*D. B. V.*

- 170-29. Baadsgaard, H., Goldich, S. S., Nier, A. O., and Hoffman, J. H. The reproducibility of A^{40}/K^{40} determinations: Am. Geophys. Union Trans., v. 38, no. 4, p. 539-542, 1957.

The reproducibility of the A^{40}/K^{40} method as studied by replicate determinations on the same sample, on different samples from a rock unit, and by interlaboratory check is within 5 percent of the age of the rock.—*M. C. R.*

- 170-30. Goldich, S. S., Baadsgaard, H., and Nier, A. O. Investigations in A^{40}/K^{40} dating: Am. Geophys. Union Trans., v. 38, no. 4, p. 547-551, 1957.

A number of potassium-bearing minerals and rocks have been studied with reference to their potential use in geochronology. The A^{40}/K^{40} ratios of cogenetic mica and feldspar were investigated, and in a group of unaltered granites and granitic gneisses ranging in age from 500 to 2,500 million years, the feldspars commonly show an argon deficiency of 35 percent compared to the micas. Thermal alteration of granite, however, may affect biotite to a greater degree than the associated feldspar, and in areas where thermal history subsequent to the initial crystallization is suspected, dating of both feldspar and mica may be particularly useful. Replicate determinations on crushed feldspar (40-60 mesh) showed no measurable leakage of argon over a period of 4-12 months. Stilpnomelane samples proved to be useless for dating. A series of samples representing progressive metamorphism from slate to phyllite to schist to coarse gneiss gave concordant A^{40}/K^{40} ages, and fine-grained sericitic materials have been used to advantage for dating an orogeny in central Minnesota.—*Authors' abstract*

- 170-31. Wasserburg, G. J., Pettijohn, F. J., and Lipson, J[oseph I.]. A^{40}/K^{40} ages of micas and feldspars from the Glenarm series near Baltimore, Maryland: *Science*, v. 126 no. 3269, p. 355-357, 1957.

Argon ages of eight samples from different parts of the Glenarm series are in reasonably good agreement and indicate that the age of metamorphism of the Glenarm series and the time of pegmatite injection was about 350 million years ago. This time corresponds to the end of the Ordovician period in the Holmes' time scale and coincides with the ages of pegmatites in New England and North Carolina. This evidence supports the view that the whole eastern Appalachian region was simultaneously subject to igneous and metamorphic activity about 350 ± 20 million years ago.—*M. C. R.*

- 170-32. Gerling, E. K. Argonovyy metod opredeleniya vozrasta iyego primeneniya dlya raschleneniya dokembriyskikh obrazovaniy Baltiyskogo i Ukrainskogo shchitov [The argon method of age determination and its use for distinguishing the Precambrian formations of the Baltic and Ukrainian shields]: *Geokhimiya*, no. 5, p. 30-42, 1956.

The K-capture constant of K^{40} is newly determined as $6.02 \times 10^{-11} \text{ yr}^{-1}$. Nearly 100 argon ages are tabulated for micas in rocks from four Precambrian magmatic cycles in the eastern part of the Baltic shield and in the Ukrainian shield, calculated on the basis of this value and a decay constant of $4.9 \times 10^{-10} \text{ yr}^{-1}$. Mica is considered to be the most suitable mineral for argon determinations because the argon is 98 to 99 percent of radiogenic origin and is retained well in the crystal lattice. It is seen that there is a difference of 500×10^6 yrs between the oldest and youngest Precambrian rocks of both shields; that the oldest granites in the Ukraine are approximately 2×10^9 yrs old; that the average age of the second magmatic cycle is 1850×10^6 yrs for the Ukraine and 1800×10^6 yrs for the Baltic shield; that the rocks of the third or Karelian cycle in the Baltic shield are 1560 to 1700×10^6 yrs old, older than Holmes' estimates; that in the Ukraine, the rapakivi granites of the Korosten'skiy massif, the granite veins, and the granites of the Malaya Yanisol' were intruded along fractures 1600 - 1700×10^6 yrs ago; that the rapakivi granite intrusions of the eastern Baltic shield are younger than the Ukrainian rapakivi, 1520×10^6 yrs, but far older than estimated according to Holmes' data; and that the Mariupol'skiye syenite, 1450×10^6 yrs, is the youngest Precambrian formation in the Ukraine.—*S. T. V., D. B. V.*

- 170-33. Polevaya, N. I. Absolyutnyy vozrast nekotorykh magmaticheskikh kompleksov SSSR po dannym argonovogo metoda [Absolute age of some magnetic complexes of the USSR according to data of the argon method]: *Geokhimiya*, no. 5, p. 43-53, 1957.

The results of argon age determinations are presented for 36 intrusive and 11 extrusive rocks of late Mesozoic and Cenozoic age, 9 from Kimmeridgian (early Mesozoic), 12 from upper Paleozoic complexes, and 8 Voznesenskiye granites from the Primorskiy Krai (Maritime Territory); and for 25 Caledonian intrusives from the Tuva Autonomous Region, 25 igneous rocks from various places in the U. S. S. R., and 21 Precambrian rocks from the Ukraine. It is concluded that the argon method gives good results for rocks younger than Precambrian if the samples are reasonably fresh and unaltered. As in the lead method, determinations on Precambrian rocks are more difficult. Contradictory data are often obtained from different mineral constituents of the

same granite, probably because of the particular conditions of formation of Precambrian igneous rocks and their complex geologic history. Reliable ages of such rocks can only be obtained by use of different methods on different minerals together with detailed geologic and petrologic study.—*S. T. V., D. B. V.*

- 170-34. Zeller, Edward J., Wray, John L., and Daniels, Farrington. Factors in age determination of carbonate sediments by thermoluminescence: *Am. Assoc. Petroleum Geologists Bull.*, v. 41, no. 1, p. 121-129, 1957.

There are at least two genetic types of thermoluminescence shown by calcium carbonate: one developed at the time the crystals are formed, the other produced by radiation damage with gamma rays or other high-energy radiation. The two types react differently to pressure and thus can be qualitatively separated. The quantity of gamma rays necessary to reproduce the natural thermoluminescence can be determined experimentally; this quantity, divided by the natural radiation rate gives an index that is related linearly to geologic age. Errors may be introduced by the chemical and physical nature of the material involved, the procedure, or the apparatus. Nevertheless, the tests of the method are said to be more encouraging than any obtained before.—*M. C. R.*

EARTH CURRENTS

- 170-35. Utzmann, R., and Favre, B. Influence de la non-cylindricité des structures sur le champ tellurique. Étude sur modèles réduits pour les anticlinaux résistants [Effect of the non-cylindricity of structures on the telluric field. Study on reduced models for resistant anticlines]: *Rev. Inst. Français du Pétrole*, v. 12, no. 2, p. 135-144, 1957.

After a review of basic definitions concerning telluric fields, the results of model experiments on the telluric field and "area" over resistant narrow anticlines are presented graphically. It is concluded that when the length of a narrow anticline is at least five times the depth of the substratum, the field along a vertical cross section in the central part will be that of a cylinder, and around either end, that of an infinitely long anticline. Superposition of these two profiles gives the "real" field even if the unit field (the field at infinity) is not known; a large part of the errors due to effect of neighboring structures is eliminated. In shorter narrow anticlines the maximum field decreases according to an empirical relation; a "chart of areas" is presented, from which the position, orientation, and general shape of the anticline can be determined. If an anticline is not only short but wide the shape approaches that of a dome, and application of these results leads to large errors. A study of broad anticlines is in progress.—*D. B. V.*

Kunetz, Géza. Application of the statistical properties of earth currents in practical geophysics. See *Geophys. Abs.* 170-90.

EARTHQUAKES AND EARTHQUAKE WAVES

- 170-36. Eiby, G. A. About earthquakes: 168 p., New York, Harper and Brothers, 1957.

A popular account. Seismographs, the science of seismology, and seismological data of the interior of the earth. Examples mostly from New Zealand.—*M. C. R.*

- 170-37. Gryglewicz, Zofia, and Skoczek, Hanna. Aktywność sejsmiczna w 1955 r [Seismic activity in the year 1955]: *Acta Geophys. Polonica*, v. 5, no. 1, p. 47-58, 1957.

The strongest earthquakes of 1955, particularly those in Europe, are summarized on the basis of data from Polish seismological stations and British and American publications. Maps of epicenters for the world (differentiating between shocks of magnitudes greater than and less than 7) and southern Europe and the Mediterranean region are included.—*D. B. V.*

- 170-38. Bolt, B. A. The epicenter of the Adelaide earthquake of 1954 March 1: *Royal Soc. New South Wales Jour. and Proc.*, v. 90, pt. 2, p. 39-43, 1956.

Seismological evidence from the Adelaide earthquake of March 1, 1954, places the epicenter at $34^{\circ}.8$ S, $138^{\circ}.7$ E, a revision of the provisional location at $35^{\circ}.5$ S, $138^{\circ}.5$ E.—*V. S. N.*

- 170-39. Trikkalinos, J. Die Auswirkungen junger, sehr starker diluvialer und rezenter orogener Bewegungen im Gebiete Griechenlands [The expression of young, very strong Diluvial and Recent orogenic movements in the region of Greece]: *Geotektonisches Symposium zu Ehren von Hans Stille*, Stuttgart, Kommissions-Verlag von Ferdinand Enke, p. 64-76, 1956.

Strong orogenic and epirogenic movements have affected the peninsula of Greece and neighboring islands from Diluvial through the present time. Contemporary movements are expressed in the frequent earthquakes (more than 300 strong earthquakes within historic time). Geomorphic changes caused by the earthquakes of 373 B. C., 1861, 1864 (Locris), 1926 (Levant), and 1932 (Chalkidiki), are cited.—*D. B. V.*

- 170-40. Poddar, M. C. Preliminary report of the Assam earthquake, 15th August, 1950: *Geol. Survey India Bull.*, Ser. B, no. 2, 40 p., 17 pl., 1952.

A fairly detailed description of damage caused by the earthquake.—*M. C. R.*

- 170-41. Ritsema, A. R., and Soetadi, R. The earthquake of November 2, 1954 near Sumbawa Island: *Indonesia Kementerian Perhubungan Lembaga Meteorologi dan Geofisik, Verh.*, no. 47, 35 p., 1955.

The most destructive earthquake in recent years in Indonesia took place on November 2, 1954, near Sumbawa Island. The shock was felt most strongly in the Wera district some 35 km northeast of the town of Bima where intensity probably was not more than VIII or IX (modified Mercalli scale). Within about 200 km of the epicenter most damage seemed to be caused by a longitudinal wave, but that at greater distances by a transverse wave. The felt area was greater in the direction of regional structure than perpendicular to it. As the shock was not felt on nearby Sumba Island, the waves were screened or scattered under the volcanic island arc of which Sumbawa is a part, and the focus was not deep. Many small aftershocks were felt in the Wera and Bima districts for the first few days following the main shock, probably from the same epicenter. Extensive damage to brick and stone houses was due to poor construction.—*D. B. V.*

- 170-42. Girlanda, Antonino. Studio di un movimento sismico del Basso Tirreno, originante alla profondità di 265 km [Study of a seismic movement in the Tyrrhenian Basin originating at a depth of 265 km]: *Annali Geofisica*, v. 9, no. 2, p. 201-217, 1956.

The epicenter of the shock of December 26, 1952 has been located by Galitzin's and Calof's methods at $+39^{\circ} 46.279'$ geocentric latitude, and $+15^{\circ} 32.798'$ longitude; depth of focus was 264.6 km and origin time $23^{\text{h}}55^{\text{m}} 55.6^{\text{s}}$. Traveltime curves of *P* and *S* are best expressed by 3d-order parabolas. The average velocities are 8.55 and 4.71 km/s respectively.—*M. C. R.*

- 170-43. Cucuzza-Silvestri, Salvatore. Il periodo sismico di Pedara (Etna) del febbraio 1955 [The seismic period at Pedara (Etna) in February 1955]: *Acad. Gioenia Boll.*, ser. 4, v. 3, fasc. 7, p. 357-372, 1956.

A series of earthquakes began early in January but occurred mainly in February 1955 in a limited area around Pedara on the south flank of Etna. The swarm resembled those of 1634, 1915, and 1916. Maximum intensity was about 5-6. Seismic activity in this region is usually related to volcanic activity. The number and frequency of the recorded shocks is not such that this zone should be considered a true seismic area; the shocks were probably due to magna movements at shallow depth.—*D. B. V.*

- 170-44. Janczewski, Edward Walery. Sejsmiczna aktywność dyslokacji w podłożu karbonu Górno-Śaskiego [Seismic activity of dislocation in the Carboniferous substratum of Upper Silesia]: *Przegląd Geol.*, rok 5, no. 6, p. 280-282, 1957.

The existence of deep dislocations in the vicinity of Zabrze and Bytom (Poland), first suggested by work on three earthquakes in December 1955, is corroborated by data from subsequent shocks in the same area on January 11 (3 shocks), February 4, August 8, November 3, and December 18, 1956 and February 15, 1957. The seismic activity is confined to a zone 27 km wide in the coal basin, between the "northwest dislocation" (the most prominent) and the Tychy-Maczki line or "southeast dislocation". A curious feature of the December 18 earthquake was that immediately after the shock near Tychy (at a focal depth of 8.5 km) another strong shock at similar depth (8.8 km) occurred some distance away at Maczki. As the focal depths are all greater than 7 km, the dislocations must be in preCarboniferous strata, or at latest Lower Carboniferous. The average depth of focus is around 8 km in the eastern part of the area, and 11 or 12 km in the Rybnik district. Depth to the crystalline sial thus probably decreases from northeast to southwest but the boundary between the sial and the ultramafic intermediate layer probably lies at 17 km under the whole coal basin.—*D. B. V.*

- 170-45. Rey Pastor, Alfonso. Estudio sismotectónico de la region sureste de España [Seismotectonic study of the southeastern part of Spain]: *Inst. Geog. y Catastral Mem.*, tomo 21, no. 6, 52 p., 1951.

This presents an analysis of the seismic behavior of southeastern Spain, made at the Alicante seismological observatory. After an outline of the structure of the area, which includes the provinces of Murcia and Alicante, southern Valencia and southeastern Albacete, data on all reported earthquakes are tabulated by "seismic nuclei," and isoseismic maps are sketched for 23 earthquakes. Seismo-

tectonic maps of the whole Iberian peninsula and of the southeastern region in more detail, complete the paper.—*D. B. V.*

- 170-46. Rey Pastor, Alfonso. La comarca del Medio Segura y el sismo de Ojós (Murcia) del 2 de mayo de 1950 [The Central Segura region and the earthquake at Ojós (Murcia) of May 2, 1950]: *Inst. Geog. y Catastral Mem.*, tomo 21, no. 10, 29 p., 1951.

The earthquake of May 2, 1950 in Murcia, Spain originated from the same focus as that of August 25, 1940. The first part of this paper describes the formations, structure, and seismic history of the area, the second is a detailed analysis of the 1950 earthquake. Maximum intensity, at Ojós, was $6\frac{1}{2}$ on the Modified Mercalli scale; radius of felt area was 33 km. Weak aftershocks on the same day were felt only near the epicenter, whose coordinates are calculated as $1^{\circ}20'16''$ W long, $38^{\circ}09'20''$ N lat; the focal depth was less than 10 km; the energy according to the Gutenberg-Richter formula was 5×10^{28} ergs. The earthquake was the strongest of a series resulting from movement, during most of 1950, along the fault visible from Cieza to Archena.—*D. B. V.*

- 170-47. Gorshkov, G. P. General survey of seismicity of the territory of the USSR: *Bur. central séismol. internat. Pubs.*, sér. A, *Travaux sci.*, fasc. 19, p. 257-259, 1956.

The far eastern part of the U. S. S. R. is the most seismically active area, especially the Kurile Islands and Kamchatka. Strong earthquakes also occur in the Carpathians, the Crimean peninsula, the Caucasus, Turkmen S.S.R., and central Asia, particularly in the Tien Shan. The survey shows that the main causes of earthquakes are "existing sufficiently differentiated and intensive tectonic movements," and therefore it is supposed that the chief characteristics of the seismological regime will be preserved for a long time without important changes. This principle should be considered in dividing the territory into seismic regions.—*B. T. E.*

- 170-48. Honda, Hirokichi. The mechanism of earthquakes: *Tôhoku Univ. Sci. Repts.*, 5th ser., v. 9 supp., p. 1-46, 1957.

A review of the development of knowledge on the mechanism at the foci of earthquakes. A bibliography of 122 items is included.—*M. C. R.*

- 170-49. Gianella, Vincent P. Earthquake and faulting, Fort Sage Mountains, California, December, 1950: *Seismol. Soc. America Bull.*, v. 47, no. 3, p. 173-177, 1957.

The fault formed in the earthquake of December 14, 1950 extended along the western slope of the Fort Sage Mountains for a distance of $5\frac{1}{2}$ miles, in two segments about equal in length. The maximum displacement is 8 inches, and the faults are normal with downthrow to the west.—*M. C. R.*

- 170-50. Gotsadze, O. D. O dinamicheskoy kharakteristike ochagov Kavkazchikh zemletryaseniy [Dynamic characteristics of the foci of earthquakes in the Caucasus]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 3, p. 284-300, 1957.

Dynamic parameters of 50 earthquakes that occurred during 1951-54 in the Caucasus were determined by a modification of the Keylis-Borok method. Use of the ratio of the amplitudes of the displacements of longitudinal and transverse

waves was not very effective because of the complicated geology of the Caucasus; the dynamic characteristics determined by the signs of the displacement of the incident longitudinal wave and of the horizontal component of the displacement of the ground in the transverse wave were found to be more reliable. Direct and diffracted *P* and *S* waves were used. The results of the study are presented as stereographic projection on 15 maps.—*S. T. V.*

- 170-51. Ingram, R. E. Fault plane of the Chile earthquake, December 7, 1953: *Seismol. Soc. America Bull.*, v. 47, no. 3, p. 281-285, 1957.

Directions of motion indicate the fault movement at the source to be transcurrent, either on a plane striking N66°W and dipping 55° NE or on a plane N32°E and dipping 79°SE. *P* and *PKP* are most useful for solution of the problem, clear readings of *pP* of almost equal value. Readings of *PP* are useful when a group of stations agree but isolated readings do not seem to be good evidence—*M. C. R.*

- 170-52. Ritsema, A. R. Pacific and 'Mediterranean' earthquake mechanisms: *Am. Geophys. Union Trans.*, v. 38, no. 3, p. 349-353, 1957.

Fault-plane solutions for 97 earthquakes in the circumpacific belt and 52 in the Mediterranean-Trans-Asiatic belt indicate that the fault movements in more than half the shocks in the shallow zone are transcurrent, and there are more normal fault movements than reversed. In the intermediate zone in the Mediterranean belt reversed-fault movements predominate and in the deep zone, normal-fault movements. At intermediate and deep levels in the Pacific belt, the majority of shocks result from transcurrent faulting.—*M. C. R.*

- 170-53. Ritsema, A. R. Earthquake-generating stress systems in southeast Asia: *Seismol. Soc. American Bull.*, v. 47, no. 3, p. 267-277, 1957.

The type of fault movement in 28 earthquakes in southeast Asia has been determined by Byerly's method as modified by Ritsema; the stress system that caused the earthquake is then derived by assuming that the principal stress components are directed at angles of 45° to each of the nodal planes in the focus. In the earthquakes investigated, transcurrent fault motion was dominant in the crust, reversed faulting at intermediate depths, and normal faulting at the deepest levels. At shallow and intermediate levels horizontal pressure earthquakes are in the majority, and at deep levels, horizontal tension shocks. Most of the crustal earthquakes are horizontal pressure shocks with the pressure component directed about perpendicular to the seismic zone; at depths of 200-250 km horizontal tension components perpendicular to the zone predominate. At deeper levels, horizontal tension components perpendicular to the zone are nearly always combined with vertical pressure components.—*M. C. R.*

- 170-54. Mühlhäuser, Siegfried. Herdmechanische Vorgänge bei einigen zirkumpazifischen Erdbeben [Focal mechanisms of some circumpacific earthquakes]: *Tellus*, v. 9, no. 1, p. 104-117, 1957.

The mechanisms at the foci of 11 earthquakes in the circumpacific belt during 1931-50 have been determined by the method given by Byerly and developed by Hodgson. In general the strikes of the fault planes coincide with structural lines. Most fault planes have a rather steep dip; those with smaller dips are in the north and northwest part of the belt. The fault plane dips under the continent in Central and South America, and the northwest part of the circumpacific belt, in Alaska, the western part of the Aleutian Islands, the southeast

coast of Kamchatka, and in the area between the Loyalty Islands and New Hebrides. Elsewhere, the fault plane dips toward the Pacific. In the north-western Pacific the motions are often perpendicular to the strikes of the fault planes, but in other areas both horizontal and vertical motions occur.—*M. C. R.*

- 170-55. Honda, Hirokichi, Masatsuka, Akira, and Emura, Kinya. On the mechanism of the earthquakes and the stresses producing them in Japan and its vicinity (Second paper): Tōhoku Univ. Sci. Repts., 5th ser., v. 8, no. 3, p. 186-205, 1957.

By use of so-called mechanism diagrams, which shows the direction of maximum pressure and maximum tension and from which nodal planes and directions of motion of the *P* waves can be obtained, 34 deep earthquakes and 10 intermediate earthquakes that occurred in and near Japan between 1927 and 1949 were analyzed. It is concluded that the directions of the horizontal components of maximum pressure are perpendicular to the trends of the deep and intermediate earthquake zones and that there is a tendency for the Pacific side to be forced down and toward the Asiatic continent relative to the continental side.—*M. C. R.*

- 170-56. Gutenberg, B[eno]. Effects of ground on earthquake motion: *Seismol. Soc. America Bull.*, v. 47, no. 3, p. 221-250, 1957.

Earthquake damage at a given location depends on properties of the arriving elastic waves, of the ground at the shaken site, and of the structures involved. To investigate effects of the ground on the motion at the surface, five identical seismographs have been operated temporarily at 25 locations within 30 miles from the Seismological Laboratory of the California Institute of Technology, Pasadena, and their records have been compared with those written by an identical instrument recording in routine at the Seismological Laboratory. The ratio of amplitudes at sites on fairly dry alluvium more than 500 feet deep to those at the Seismological Laboratory (on crystalline rock) is frequently 5:1 or more for earthquake waves having periods of 1 to 1½ sec. For waves having periods of 0.1± sec and waves having periods exceeding 10 sec (length more than 10 miles) the corresponding differences in amplitudes are small. Amplitudes of earthquake waves and of the continuous unrest of the ground recorded at sites on water-saturated soft ground may be ten times those recorded at the Laboratory. The period of waves for which the response relative to that at the Seismological Laboratory is greatest usually decreases as the thickness of the alluvium decreases and is about ¼ sec at stations on alluvium 100 ± feet thick. At stations on crystalline rock the motion of the ground does not differ significantly from that at the Laboratory for waves having periods exceeding ¼ sec.

At sites on alluvium, relatively strong shaking lasts several times as long as at those on crystalline rock; usually this ratio decreases with decreasing thickness of the alluvium. Ground effects may produce appreciable differences in duration and amount of shaking even at localities only a fraction of a mile apart. The importance of selecting crystalline rock or at least dry ground and avoiding water-saturated soft ground for foundations of buildings to reduce potential earthquake damage is stressed.—*Author's abstract*

- 170-57. Housner, George W. Interaction of building and ground during an earthquake: *Seismol. Soc. America Bull.*, v. 47, no. 3, p. 179-186, 1957.

Analysis of accelerograms of the Arvin-Tehachapi earthquake of July 21, 1952 obtained in two buildings approximately 75 miles south of the epicenter indicate

there was not a significant amount of ground coupling and thus that on very soft ground a low, stiff building is benefited by having large dimensions as long as the foundation structure is sufficiently strong.—*M. C. R.*

- 170-58. Lensen, G. J., Stevens, G. R., and Wellman, H. W. The earthquake risk in the Wellington district: New Zealand Sci. Rev., v. 14, p. 131-135, 1956.

The circumpacific mobile belt crosses central New Zealand as a southwest trending zone 175 miles wide; the Wellington district is at its center. The belt is crossed by numerous faults with clockwise, transcurrent displacement causing a northeast displacement of the Tasman Sea side relative to the Pacific side of probably 300 miles since Jurassic time. From evidence of river terraces, fault movement is thought to have been uniform in the 10,000 years since the last glaciation and it is estimated that, in the Wellington district, a destructive earthquake may occur every 80 years. There is a 70 percent chance of a destructive earthquake in 100 years and a 45 percent chance of one in 50 years. This estimate may be made more exact by surveying across faults, retriangulation across the mobile belt, and levelling to determine any gradual slip along fault planes.—*V. S. N.*

- 170-59. Kirnos, D. P., and Kharin, D. A. Basin equipment of seismological stations in the U. S. S. R.: Bur. central seismol. internat. Pubs., sér. A, Travaux sci., fasc. 19, p. 357-371, 1956.

The 70 stations at which regular seismological observations are carried on are divided into two types: the general type or those designed to register both distant and near earthquakes and the regional type, designed for registration of feeble local earthquakes. General stations are equipped with instruments that have pendulum periods of 12.5 sec, galvanometer periods of 1 sec and constant magnification of 1,000 for periods of 0.25 to 10 sec. At the regional stations the instruments have a sharp peak of magnification (20,000 to 40,000) for periods of 0.3 to 0.6 sec. Instruments of both kinds and strong-motion seismographs are described and shown in photographs.—*M. C. R.*

- 170-60. Wieladek, Romuald, and Wojtczak, Bóżenna. Application of the generalized adjustment method in the determination of coordinates of the seismic focus on the basis of several different phases: Acta Geophys. Polonica, v. 5, no. 1, p. 3-10, 1957.

Wieladek's generalized adjustment method is applied to determination of the coordinates of an earthquake focus and of their accuracy by mathematical adjustment embracing several different earthquake phases, and illustrated by a numerical example for the P_s and S_s phases of the Gran Sasso earthquake of September 5, 1950. The results seem to show that the P_s and S_s phase times are approximately equally accurate and that the interdependence of these times is relatively small. To support these conclusions similar calculations must be carried out for a large number of earthquakes recorded at many stations.—*D. B. V.*

- 170-61. Ritsema, A. R. Amplitudes of bodily seismic waves: Indonesia Mad-jalah Ilmu Alam, v. 112, pt. 2, p. 135-152, 1956.

Numerical values of the amplitude over period (A/T) ratio for P -waves are calculated as a function of focal depth and epicentral distance Δ . Jeffreys'

velocity distribution of longitudinal waves in the earth's mantle is used. Two different velocities of longitudinal waves in the crust of the earth are considered, viz $V_0=5.6$ and $v_0=7.75$ kmps. It is seen that the ratio of the vertical ground movement over the period (A_w/T) for P -waves of earthquakes with a focal depth between 0.00 and 0.12 R is almost independent of the assumed value of v_0 . The ($A_w/T, \Delta$) function therefore is very useful for a magnitude determination of the earthquakes with such a focal depth.—*Author's abstract*

- 170-62. Shurbet, D. H., and Ewing, Maurice. T phases at Bermuda and transformation of elastic waves: *Seismol. Soc. America Bull.*, v. 47, no. 3, p. 251-262, 1957.

Study of T phases recorded at Bermuda from 16 earthquakes show that the P phase as it advances from the deep ocean toward a steep slope is transformed to the T phase. Lg may also be transformed to a T phase. Two phases recorded at Palisades, Halifax, and Ottawa apparently result from transformation of a T phase to a phase traveling through the continent at a velocity of about 3.5 kmps.—*M. C. R.*

- 170-63. Båth, Markus. Shadow zones, travel times, and energies of longitudinal seismic waves in the presence of an asthenosphere low velocity layer: *Am. Geophys. Union Trans.*, v. 38, no. 4, p. 529-538, 1957.

Theoretical computations, using the ray theory, are made of the extent of the shadow zone, travel times, and energies of longitudinal waves, assuming an asthenosphere low-velocity layer. A profile with velocity as an exponential function of the radius in each layer leads to relatively simple expressions both of distances and travel times. The shadow zone has a maximum width for a focus in the level of maximum velocity ($h=50$ km in our model) and vanishes for foci about 20 km below the level of minimum velocity. Outside the shadow zone a caustic is formed with high energy concentration, beyond which the travel time curve shows two branches, the latter existing only up to a certain distance. There is much less energy arriving on the second of these branches than on the first. Other effects which may explain the arrival of energy also within the shadow zone are discussed qualitatively. Such effects include reflections from the Earth's surface and at internal discontinuities, scattering, diffraction.—*Author's abstract*

- 170-64. Oliver, Jack [E.], and Ewing, Maurice. Higher modes of continental Rayleigh waves: *Seismol. Soc. America Bull.*, v. 47, no. 3, p. 187-204, 1957.

A long dispersive train of waves corresponding to higher modes of the Rayleigh wave equation (including Sezawa's M_2 wave) for the continental crust-mantle system has been identified in the records of the Arctic earthquake of June 3, 1956. Observed particle motion was elliptical and retrograde, in agreement with theory. Waves corresponding to the short-period branches of the higher modes of the Rayleigh equation can account for the vertical and longitudinal components of Lg . The large amplitudes of Rg and peculiar reversals of dispersion in Rg from earthquake to earthquake seem to depend on the broad flat minimum of the group velocity curve of the Rayleigh mode.—*M. C. R.*

- 170-65. Bolt, B. A. Velocity of the seismic waves *Lg* and *Rg* across Australia: *Nature*, v. 180, no. 4584, p. 495, 1957.

Riverview records of seven Australian earthquakes show clear *Lg* phases in 6 shocks and *Rg* in 2 shocks. The mean velocity of *Lg* is 3.50 ± 0.07 km/s, and of *Rg* 3.03 ± 0.07 km/s, in striking agreement with velocities obtained for North America and Eurasia.—*M. C. R.*

Keylis-Borok, V. I. The theory of waves excited during dislocation. See *Geophys. Abs.* 170-72.

EARTH TIDES AND RELATED PHENOMENA

- 170-66. Nishimura, E[iichi], Ichinohe, Tokio, and Nakagawa, Ichiro. A consideration on earth tidal change of gravity: *Tellus*, v. 9, no. 1, p. 118-126, 1957.

Gravimetric observations were made for a period of one month at Kyoto, Chikubushima, and Shionomisaki with a Worden gravimeter to obtain accurate values of the tidal factor of gravity and to detect, if possible, the local character of the factor. The three stations were selected to provide diverse conditions from the standpoint of effect of ocean tides and subsurface structure. The tidal factors obtained at the three stations were 1.18, 1.21, and 1.23, respectively. There is general agreement, but the third figure, if significant, may represent differences in the effects of ocean tides and subsurface structure.—*M. C. R.*

- 170-67. Schweidler, Felix. Die Schwankungen der Erdachse [Fluctuations of the earth's axis]. *Naturw. Rundschau*, Jahrg. 10, Heft 6, p. 205-207, 1957.

As displacements of the pole are related to mass displacements in the interior, information on the internal constitution of the earth can be obtained by application of the appropriate laws of mechanics to observations of such displacements. Information on the earth's elasticity can be deduced from the fact that the free period of polar variation is greater than the theoretical value of 10 months. The annual component of polar movement describes an elliptical path whose long axis is remarkably constant in the direction of the 30° W meridian; this apparently reflects the inequality between the hemisphere containing the large landmasses of Eurasia and Africa and the opposite hemisphere, largely ocean, but the reason is not clear. Possibly vast accumulation of cold air all year over Asia is sufficient to cause displacement of the main axis of inertia and with it the axis of rotation; possibly ocean currents also play a part. The component having the 14-month period of variation shows no ellipticity, reflecting the fact that the equatorial diameters of the earth are essentially equal. It would be of interest to find a component capable of producing a north-south displacement of continents; such displacement is suggested by data of latitude stations, but without certainty. Variation in the length of the day is related indirectly to polar displacements, for mass displacements at the surface change the moment of inertia and result not only in displacement of the axis but also in variation in speed of rotation.—*D. B. V.*

ELASTICITY

- 170-68. Volarovich, M. I., and Gurvich, A. S. Issledovaniye dinamicheskogo modulya uprugosti gornyykh porod v zavisimosti ot temperatury [Study of the dynamic moduli of elasticity of rocks as affected by

temperature]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 417-425, 1957.

Young's modulus and internal friction were determined for several specimens of different rocks at temperatures up to 1,000° C by using the resonance of flexural vibrations in a bar. Young's modulus of granite dropped to one-sixth of its value when the temperature reached 600° C, but then remained almost unchanged to 1,000° C. The variation of the modulus with temperature was less sharp in basalt. An important increase in internal friction was also found in many rocks. The minimum Young's modulus and the maximum damping in sandstone and quartzite were at 575° C, the point of the polymorphic transformation of quartz. Numerical results of the experiments are given in graphs and tables.—*S. T. V.*

170-69. Hameister, Ernst. Gesteinsphysikalische Untersuchungen im Laboratorium und deren Anwendung in der Geologie und Petrologie [Petrophysical investigations in the laboratory and their application to geology and petrology]: Geologie, Jahrg. 5, Heft 2, p. 123-126, 1956.

This note on petrophysics (the determination of the physical properties of rocks in order that geophysical anomalies may be more accurately interpreted) is a review of the geomechanical factors (density, permeability, and elastic properties) and the methods of determining them used in the Laboratorium für Gesteinsphysik des VEB [People's Own Enterprise] Geophysik, in Leipzig. Data on the density of some rocks and minerals and its relation to seismic velocity and petrographic characteristics are included.—*D. B. V.*

170-70. Röhrlsberger, H[ans]. Zur seismischen und petrographischen Charakterisierung einiger Molassegesteine, einschliesslich der Beschreibung von Methoden der Korngrössenbestimmung in Festmaterial [On the seismic and petrographic characteristics of some Molasse rocks, including the description of methods of determining grain sizes in consolidated material]: Beitr. Geologie Schweiz, Geophysik, no. 1, 91 p., 1957.

After a review of static and dynamic laboratory methods and of field methods of determining the elasticity of rocks, the field method used in this investigation of four sandstones and four conglomerates from the Swiss Molasse is described (small explosive charges at the surface were recorded at distances from 5 to a few hundred m). The results of the seismic and petrographic measurements are tabulated and discussed from different points of view. In these highly homogeneous rocks the spread of velocity values was found to be 7 percent in profiles 10 m long. The yellow sandstone from Ostermundigen shows a longitudinal wave velocity of 2.22 km/s and transverse velocity of 1.27 km/s, small values for a stone used for building purposes; the high porosity (18 to 20 percent) may be the explanation. The blue Ostermundigen sandstone, identical with the yellow but below ground water level, has a longitudinal velocity of 3.05 km/s. The sandstone from Bäch, with 7 percent porosity and considerably affected by Alpine deformation, shows the astonishingly high value of $v_l=4.48$ km/s. The conglomerates show great variation, from very low values in weathered rocks to as high as 5 km/s. The last chapter concerns different procedures for determining grain size, all based on distribution of spheres, in polished surfaces, thin sections, or drill cores.—*D. B. V.*

- 170-71. Ewing, Maurice, Jardetzky, Wenceslas S., and Press, Frank. Elastic waves in layered media: 380 p., New York, McGraw-Hill Book Co., Inc., 1957.

A comprehensive treatment of both experimental and theoretical aspects of the propagation of elastic waves in layered media. Among the topics considered are the propagation of Rayleigh and Love waves in the ocean bottom and across continents, Rayleigh waves in the mantle, microseisms, ground roll in seismic prospecting, and Sofar propagation.—*M. C. R.*

- 170-72. Keylis-Borok, V. I. O teorii voln, vznikayushchikh pri sdvige [The theory of waves excited during dislocation]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 440-448, 1957.

■ The correlation between a point source of elastic waves—assumed as the model of the focus of the earthquake—and static dislocation resulting in the ground after the passage of these waves is being investigated. The static field which is postulated by Love in his theory of such a dislocation, is also analyzed. The possibility is discussed of applying this theory to the problem of determining the appropriate model of the focus. The author states that a correct analysis of this theory leads to a conclusion that is in full agreement with the generally accepted notion of dislocation as a combination of a dipole with a moment.—*Author's summary, S. T. V.*

- 170-73. Honda, Hirokichi, Nakamura, Kōhei, and Takagi, Akio. The disturbance in a semi-infinite elastic solid due to a linear surface impulse: Tōhoku Univ. Sci. Repts., 5th ser., v. 8, no. 1, p. 86-92, 1956.

Mathematical expressions are obtained for the propagation in a semi-infinite medium of dilatational and distortional waves generated by a normal impulse applied uniformly along a line on the surface. Results of model experiments by Takagi (Geophys. Abs. 170-83) are in general agreement with those obtained theoretically.—*M. C. R.*

- 170-74. Honda, Hirokichi, and Emura, Kinya. The production of the two-dimensional elastic waves: Tōhoku Univ. Sci. Repts., 5th ser., v. 8, no. 3, p. 206-211, 1957.

A theoretical discussion of the production of two-dimensional elastic waves by force systems of various types applied normally on a straight line in an infinite elastic solid.—*M. C. R.*

- 170-75. Takeuchi, Hitoshi, and Kobayashi, Naota. Wave generations from line sources within the ground: Jour. Physics of Earth, v. 3, no. 1, p. 7-15, 1955.

In the study of the propagation of tremors due to line sources within the ground simple expressions are required by which the displacements at any point and at any time may easily be calculated. Using such expressions numerical examples are worked out in detail and the following results obtained: At the "epicenter" the displacement is a simple pulse followed by a gradual decrease to a permanent displacement. Rayleigh waves appear at a certain distance from the epicenter. Permanent displacements are rather large even at points far away from the origin; they are comparable to the amplitudes of Rayleigh waves at the respective points. There is no *S* phase in seismograms to be obtained for a wave origin of dilatational type.—*B. T. E.*

- 170-76. Iida, Kumizi, and Aoki, Harumi. Seismic source energy and wave energy in visco-elastic medium: Nagoya Univ. Jour. Earth Sci., v. 4, no. 2, p. 63-79, 1956.

Equations are derived for wave and strain energy for solids having internal friction. Voight and Maxwell models of the solid are assumed. A spherical cavity in the medium is considered as a seismic source of energy where a step function of pressure is applied for the Voight model and a square wave of pressure is applied for the Maxwell model. Calculations are made for various values of viscosity and time duration of the applied pressure.

For both models the attenuation of wave energy for large distances from the source may be described by a logarithmic decrement similar to that for harmonic motion; for distances close to the source, the wave energy varies in a more complicated manner, especially for the Maxwell model. It is claimed that the energy in the seismic source can be calculated from their equations if the attenuation as function of distance from the source is known.—*L. P.*

- 170-77. Malinovskaya, L. N. K metodike rascheta dinamicheskikh osobennostey seysmicheskikh voln [On the methods of computing the dynamic characteristics of seismic waves]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 426-439, 1957.

A more elementary explanation of the general method of solving the problems of reflection and refraction of seismic waves worked out by G. I. Petrashen' and his students (see Geophys. Abs. 168-64, 65, and 66). A set of curves computed by Petrashen' methods showing the final changes of amplitude and the phase angle for different cases of reflection and refraction on various boundaries is included. Malinovskaya refers to these curves as "standard seismograms." They make it possible to trace phases in seismic profiling over long distances by giving the values of the phase angle and of the amplitude at every boundary.—*S. T. V.*

- 170-78. Droste, Zofia. Kątowy rozkład gęstości energii w falach sejsmicznych [The angular distribution of density of energy in seismic waves]: Przegląd geofiz., rocznik 1 (9), zeszyt 3-4, p. 241-252, 1956.

The Keylis-Borok method of determining the dynamic characteristics of an earthquake focus is first discussed (see Geophys. Abs. 148-13330 and 151-14035), then two formulas are derived to express the entire flow of energy through the surface of a globe of arbitrary diameter in a given time unit. Two other formulas express the directional distribution of density of energy, and are illustrated by some examples of cases most commonly found in practice: straight line force, twofold force with moment, and twofold force without moment.—*D. B. V.*

- 170-79. Fedotov, S. A. O dinamicheskikh osobennostyakh otrazhennykh voln, vremya prikhoda kotorykh ne yavlyayetsya minimal'nym vozmozhnym vremenem [On the dynamic properties of reflected waves, the time of arrival of which does not appear to be a minimum possible time interval]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 575-583, 1957.

According to Fermat's principle a seismic ray reflected from a plane surface takes the shortest path and the shortest time interval from the point of departure to the point of arrival. The situation is different for curvilinear surfaces. Experiments on the reflection of seismic waves from surfaces of different curvatures show that in seismic waves which have passed focal point after reflection, the

intensity of the later phases of the waves increases, and the waves are damped more rapidly than those propagating along the minimum-time path.—*S. T. V.*

- 170-80. Nafe, John E. Reflection and transmission coefficients at a solid-solid interface of high velocity contrast: *Seismol. Soc. America Bull.*, v. 47, no. 3, p. 205-219, 1957.

Fractional energies in the outgoing waves produced by incident P , S , P' , and S' have been computed for three cases that resemble conditions at the boundary between ocean sediments and underlying rock: compressional velocity contrasts of $5/2$, $6/2$, and $7/2$, density ratio of $2.8/2.3$, and a Poisson's ratio of 0.25 in each medium.—*M. C. R.*

- 170-81. Chekin, B. S. Ob izmenenii formy volny pri otrazhenii i prelomlenii [On the change of shape of a wave during reflection and refraction]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 4, p. 448-451, 1957.

When a plane elastic wave is incident on a plane boundary at an angle smaller than the critical angle, the shape of the incident wave is repeated in the reflected and refracted waves, and only the amplitudes are changed. If the angle of the incoming wave exceeds the critical angle (total inner reflection), the shape of the wave is changed. The same phenomenon takes place when the waves are reflected or refracted on a thin layer. The media discussed are those which transmit longitudinal waves only. Five different shapes of incoming waves are considered for the case of three plane-parallel layers and the corresponding reflected and refracted waves are computed and also shown graphically.—*S. T. V.*

- 170-82. Takagi, Akio. Seismic model studies. Part 1. On Rayleigh wave: *Tōhoku Univ. Sci. Repts.*, 5th ser., v. 8, no. 1, p. 64-68, 1956.

Model studies of the propagation of elastic waves in a thin plate were made using a barium titanate disk embedded in the medium and its radial mode vibration as a wave generating source. Uniformity in intensity was obtained by surrounding the crystal with grease. The variation of amplitude of Rayleigh waves with focal depth quantitatively confirmed the theoretical results. The surface S wave predicated by Nakano and by Lapwood was not clearly recognized.—*M. C. R.*

- 170-83. Takagi, Akio. Seismic model studies. Part 2. On dilatational and distortional waves in semi-infinite solid due to a linear surface impulse: *Tōhoku Univ. Sci. Repts.*, 5th ser., v. 8, no. 1, p. 69-73, 1956.

Amplitudes of dilatational and distortional waves generated by a surface impulse were studied, using a homogeneous semi-disk of bakelite as the semi-infinite model and barium titanate transmitting and receiving transducers. Results indicate that: the principal motion of the P pulse is directed radially; its amplitude is largest in the direction making an angle of 0° with the axis of the source; the principal motion of the S pulse is transverse to the direction of propagation; and the amplitude of S is largest in a direction at an angle of about 40° with the axis of the source.—*M. C. R.*

- 170-84. Kato, Yoshio, and Takagi, Akio. Seismic model studies. Part 3. On the initial motion of dilatational and distortional waves produced by various types of forces: *Tōhoku Univ. Sci. Repts.*, 5th ser., v. 8, no. 3, p. 212-224, 1957.

Initial motions of P and S waves produced by a single force, a double force with a moment, two double forces, and a quadruplet were studied experimentally by using ultrasonic waves in a thin bakelite disk. Results obtained agreed fairly well with theory, both qualitatively and quantitatively, except that the magnitude of the S wave generated by a double force was proportional to $\sin 2\theta$ rather than $\sin \theta$. The study indicates that the distribution of initial motion of P does not give the mechanism at the source uniquely, and the distribution of initial motion of S must be considered.—*M. C. R.*

170-85. Kato, Yoshio, and Takagi, Akio. Model seismology. Part 3. Wave propagation in the step-shaped structure and on the cliff: Tōhoku Univ. Sci. Repts., 5th ser., v. 8, no. 1, p. 74-85, 1956.

Experiments on the propagation of elastic pulses in a semi-infinite elastic medium with a step-shaped surface were made, using bakelite as the model material and barium titanate crystals as transmitters and receivers. When the source is on the upper part of the step-shaped surface and the observing point on the lower part, the amplitude of Rayleigh waves decreases exponentially with the step size. When body and surface waves reach the step, new pulses are generated, from which it is deduced that the complex features recorded on a seismogram may be attributed to waves converted and scattered at surface discontinuity. The new pulses are due to a conversion of P to L_p and L_p to L_R .—*M. C. R.*

170-86. Volarovich, M. P., and Balashov, D. B. Issledovaniye skorostey uprugikh voln v obraztsakh gornykh porod pri davlenii go 5,000 kg p cm² [Study of elastic wave velocities in specimens of rocks under pressure of 5,000 kg per cm²]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 310-330, 1957.

Equipment and methods are described of measuring in the laboratory the velocity of propagation of elastic waves of ultrasonic frequencies through specimens of rocks under hydrostatic pressures of as much as 5,000 kg per cm². Nitrogen is used to produce the pressure on the test specimen. Detailed measurements were made on specimens of basalt, syenite, and dolomite. Under the pressures of 500 to 1,000 kg per cm² the velocities of longitudinal waves increased rapidly; after 1,000 kg per cm² the increase of velocity became more and more slow, owing to the closing of pores of the tested rocks. The velocity of longitudinal waves in basalt and dolomite increases at 5,000 kg per cm² pressure by 10 to 12 percent, in syenite by about 20 percent.—*S. T. V.*

170-87. Hameister, Ernst. Über Wellenausbreitung und elastische Eigenschaften in Sedimentgesteinsproben aus Tiefbohrungen [On wave propagation and elastic properties in samples of sedimentary rocks from deep borings]: Geologie, Jahrg. 6, Heft 2, p. 141-147, 1957.

The longitudinal and transverse wave velocities and elastic constants (Poisson's ratio and modulus of elasticity) have been determined experimentally on 12 sedimentary rocks from deep borings in Germany, using the "Rentsch, Pirna/Sa" ultrasonic apparatus. The rock types include sandstone, mudstone, clay shale, conglomerate, limestone, anhydrite and gypsum. Results are tabulated.—*D. B. V.*

- 170-88. Nafe, John E., and Drake, Charles L. Variation with depth in shallow and deep water marine sediments of porosity, density and the velocities of compressional and shear waves: *Geophysics* v. 22, no. 3, p. 523-552, 1957.

In a study of the dependence of the velocity of compressional waves in marine sediments upon the thickness of overburden, the velocity-depth relationship in shelf sediments is shown to be distinctly different from that in deep basin sediments. The difference between the two cases may be illustrated by comparing the straight lines that best represent the data. These are $V=1.70Z+1.70$ [in] shallow water [and] $V=0.43Z+1.83$ [in] deep water where V is in km/sec and Z is in kilometers. Shallow and deep water are defined arbitrarily to be under 100 fathoms and over 1,500 fathoms respectively.

The observed variation of average compressional velocity in the shallow and deep water sediments, taken together with the known limited range of variation of velocity for a given porosity, yields limits in turn upon the porosity-depth dependence in the two environments. It is shown that at the same depth of overburden porosity is much greater in deep water sediments than in shallow.

A physical argument is presented to show that there is implicit in the observed narrow range of variation of velocity with porosity a simple relation between porosity and rigidity. Thus quantitative estimates of shear velocity may be made from compressional velocity alone. In this way the original data are used to place rather narrow limits on the depth variation of shear velocity, porosity, and density. A number of comparisons with observation are employed to test the conclusions at each stage of the discussion.—*Authors' abstract*

ELECTRICAL EXPLORATION

- 170-89. Yakubovskiy, Yu. V., and Lyakhov, L. L. *Elektrozvedka* [Electrical exploration methods]: 350 p., Moscow, Gosgeoltekhnizdat, 1956.

This is a textbook on electrical exploration methods written for the use of students in geological exploration "tekhnikums" (a tekhnikum in the U. S. S. R. is an engineering school at a lower level than a university).—*S. T. V.*

- 170-90. Kunetz, Géza. *Anwendung statistischer Eigenschaften der Erdströme in der praktischen Geophysik* [Application of the statistical properties of earth currents in practical geophysics]: *Freiberger Forschungshefte*, C 32 Geophysik, p. 5-19, 1957.

Although the absolute value of the telluric current field at a given point at a particular instant may bear no relation to the structure of the ground, the statistical behavior of the variations of the field at that point during a certain interval may permit rather easy and exact determination of relative parameters and yield interesting supplementary information. An "absolute ellipse" describing the field can be constructed from the variations during 15-minute intervals; comparison with ellipses constructed from mean density of vector directions and mean vector amplitudes shows close correspondence. The method is rapid, as total variations of the components of the field can be measured directly in the field with appropriate counters, and the absolute surface area can be immediately derived from them. Accuracy is increased, especially in disturbed areas, because the mean values represent large numbers of measurements. Another advantage is the additional information, given by the direction and ellipticity of the absolute ellipse, on the preferred orientation of the field and degree of "canalization" of the variations around this direction.—*D. B. V.*

- 170-91. Petrucci, Giuseppe. Das elektrische Feld einer senkrecht einfallenden Flozstruktur [The electrical field of a vertical disturbing layer]: Gerland's Beitr. Geophysik, Band 66, Heft 1, p. 58-64, 1957.

A discussion of the effect of the electrical field in a homogeneous body in which there is an infinite thin vertical layer of infinitely great conductivity that does not reach the surface (a metallic vein). Classic formulas pertain if the problem is transposed to a vertical conductor reaching the surface.—*Author's abstract, M. C. R.*

- 170-92. Ovchinnikov, I. K. Elektrozvedka kolchedannykh zalezhey pod pogloshchayushchim poverkhnostnym sloym [Electrical exploration methods for pyrite deposits beneath a screening surface layer]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 471-478, 1957.

This is a discussion of the screening effect of a conductive surface layer of the crust in electrical exploration for ore deposits. Such a disturbing effect is often observed over pyrite deposits and is accentuated when the upper screening layer is not homogeneous but consists of two or more layers of different resistivity. In this case it is recommended that all screening layers be replaced by one layer of the same total thickness h and of a fictitious average resistivity

$$\bar{r} = \frac{1}{h} \int_0^h r(z) dz;$$

$r(z)$ is the resistivity at depth z . Results of theoretical investigations of such a composite profile are cited and experiments on an appropriate model are described. By this method several pyrite deposits on the eastern slopes of the Urals were explored and subsequent drilling fully confirmed the results obtained.—*S. T. V.*

- 170-93. Ryss, Yu. S. Eksperimental' nye issledovaniya vyzvannoy polarizatsii elektronnykh i ionnykh provodnikov [Experimental investigation of induced polarization in electronic and ionic conductors]: Vses. nauchno-issled. inst. razved. geofiz. Voprosy rudnoy geofiz., Sbornik statey 1, p. 120-127, 1957.

Experimental measurements of the intensity of induced polarization under different conditions were made in a model consisting of a square tank 1 m long filled with different materials such as clay, moistened sand, and plates of glass. The clay represented an ionic medium of low resistivity, the sand a medium of high resistivity. The ratio of the resistivities of clay and sand was kept between the limits 1:10 and 1:20. Ore bodies were simulated by copper plates inserted into the mass filling the tank. Three quantities were measured: the intensity I of the feeding current, the difference of the potential ΔU producing the current I , and the intensity of the induced polarization ΔU_{ind} . The value ΔU_{ind} was measured in the moment of the beginning of the drop of its intensity. Thirteen different setups were tested and the results of the experiments are represented in graphs. The conclusions are that: anomalies produced by ore bodies and by rocks of high resistivity can be separated by comparison of the graphs of ΔU_{ind} and ΔU ; when the anomalies are produced by ore bodies and rocks simultaneously it is necessary to look for the difference in the general run and in the details of the ΔU_{ind} and ΔU graphs; a reliable separation of anomalies produced

by ore bodies from those caused by rocks of high resistivity can be made by comparing ΔU_{ind} and $\epsilon \Delta U$, but only on the basis of very precise measurements.—*S. T. V.*

- 170-94. Belluigi, Arnaldo. Weiterentwicklung der Verfahren der theoretischen Geoelektrik nach Buchheim [Further development of Buchheim's theoretical geoelectrical method]: Freiburger Forschungshefte, C 32 Geophysik, p. 65-88, 1957.

After discussion of the advantages and limitations of Buchheim's geoelectrical method, Belluigi develops the procedure further to obtain solutions of the second approximation and thus give more quantitative results. This broadens the procedure to apply to "deep structures of lateral type" which are observed rather often in practice.—*D. B. V.*

- 170-95. Kamenetskiy, F. M., Kaufman, A. A., and Yakubovskiy, Yu. V. O vibore optimal'noy chastoty pri induktivnykh metodakh elektro-razvedki [Selection of the best frequency in using the inductive methods of electrical exploration]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 200-210, 1957.

The problem is discussed of the correlation between the frequency of the alternating electromagnetic field induced in the ground and the changes in the field pattern caused by the presence underground of disturbing bodies of given shape and electric properties. The solutions are established on the basis of the known equations of the theory of electromagnetic field. Sphere, cylinder and disk were discussed. Solutions are also obtained by experiments on models employing the frequency ranging from 50 to 4800 hertz. The conclusions of the authors are formulated as follows: the amplitude of anomalous field with increasing frequency asymptotically increases towards its maximum, whereas the phase anomaly first increases but later drops down to zero. It is advisable to choose the optimum frequency with the phase anomaly not being equal to zero and sufficiently high amplitude anomaly. It is also advisable to run the tests with two different frequencies, one for the localization of the bodies in the upper layer of the ground, another for greater depth.—*S. T. V.*

- 170-96. Barsukov, O. M. O'svyazi izmeneniya amplitudy i fazy elektricheskogo polya s elementami magnitnogo ellipsa polarizatsii [Correlation between the variation of amplitude and phase angle of the electric field with the elements of the magnetic ellipse of polarization]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 404-406, 1957.

Relations between the elements of the electric and magnetic field were studied, using the simplest case: when the electric field is produced by an infinite cable laid on the ground through which an alternating current is passed through an infinitely distant ground point.—*S. T. V.*

- 170-97. Barsukov, O. M. Sposob kombinirovannogo vzbuzhdeniya peremennogo elektromagnitnogo polya [A method of combined excitation of an alternating electromagnetic field]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 12, p. 1488-1494, 1956.

A new method is suggested for the location of disturbing bodies by using the changes produced by them in the alternating electromagnetic field. Several field patterns are constructed for the cases which can be theoretically evaluated, such as the field produced by a very long straight cable stretched over the

surface of the earth. A summation of individual fields (normal and disturbing) can be made if the phase differences are taken into account by making the summation vectorially. Comparison of the field pattern with those produced by the combination of simple fundamental cases makes its possible to determine the position of the disturbing bodies producing the observed anomaly. The greatest disturbance of the standard field is produced in the vicinity of the foreign bodies that change the initial homogeneity of the medium. Several grapho-analytical figures and curves illustrate the application.—*S. T. V.*

- 170-98. Yoffe, L. M., Komarov, V. A., and Semenov, M. V. Ob ispol'zovanii pomekh promyshlennosti peremennykh tokov dlya poiskovykh tseley [On the use of disturbances produced by industrial alternating currents in prospecting]: Vses. nauchno-issled. inst. razved. geofiz. Voprosy rudnoy geofiziki, Sbornik statey 1, p. 128-129, 1957.

Observations of industrial 50-c alternating currents in the ground were traced to leakage of a high voltage line. Variations in the intensity of the currents were investigated by keeping one observing point fixed and moving another over the length of a selected profile. The minimums of the readings were found to correspond to ore bodies with high electrical conductivity.—*S. T. V.*

- 170-99. Tornquist, Björn Hans. Über elektromagnetische Prospektion vom Flugzeug aus [On electromagnetic prospecting from aircraft]: Freiburger Forschungshefte, C 29 Geophysik, p. 19-25, 1956.

Airborne electromagnetic prospecting methods have been developed from the Sundberg and Slingram ground methods. From a purely geophysical standpoint the former is better because fairly homogeneous fields are generated, thus simplifying the calculations and interpretation. Good depth of penetration is possible; under favorable conditions about 200 m has been attained in northern Scandinavia. The chief disadvantage lies in the fact that ground instruments are still required, so that the maneuverability, speed, and economy of flying are not fully utilized; also, telephone lines may cause considerable interference. As an airborne method therefore, the Sundberg should be used for detailed investigations in limited areas. The advantage of the Slingram method lies in the fact that all the equipment can be carried in the plane; but depth of penetration is only 75 to 100 m. The method can be economical for reconnaissance of large areas, simultaneous with aeromagnetic and radiometric measurements. The electromagnetic equipment must be able to detect poor conductors such as disseminated copper ores as well as good conductors such as compact pyrite ores. At medium frequencies poor conductors produce only a phase shift in the measured field intensity, good conductors only amplitude variations. The apparatus used at Boliden, Sweden and some of its results are described briefly.—*D. B. V.*

- 170-100. Barsukov, O. M. Graduïrovka amplitudnofazovoy elektrorazvedochnoy apparatury [Calibration of amplitude and phase measuring instruments used in electric exploration]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 4, p. 523-524, 1957.

Harmonic electromagnetic fields are used in electric exploration, and thus the vector of the magnetic component H_a (as well as that of the electric one) at the point of observation described during one period is an ellipse with half-axes

a and b , so that $H_a = b \cos \alpha \sqrt{(a^2/b^2) \tan^2 \alpha + 1}$; $\psi + \arcsin (1/(a^2/b^2 \tan^2 \alpha + 1))$ where ψ is the phase angle formed by H_a and the axis a . By using these two formulas, the values of H_a and ψ can be computed for any value of $\frac{H'_a}{H_a}$ and compared with the readings on the calibrated instrument. In this manner it is possible to calibrate simultaneously the values of H and ψ . It is also possible to compare separately either H or ψ . This method makes it possible to make calibrations even in the field.—*S. T. V.*

- 170-101. Vacquier, Victor, Holmes, Charles R., Kintzinger, Paul R., and Lavergne, Michel. Prospecting for ground water by induced electrical polarization: *Geophysics*, v. 22, no. 3, p. 660-687, 1957.

When direct current introduced into the ground at two points is interrupted, a small voltage, which may take several minutes to decay, appears between another pair of electrodes. This effect, called by C. Schlumberger "provoked polarization," is found useful in prospecting for ground water. Laboratory experiments indicate that induced polarization (I.P.) depends on cation exchange in the clay minerals contaminating the aquifers. It is suggested that the effect is due to electro dialysis of the clay within the aquifer, which acts as a distributed electronegative membrane. The magnitude of the I.P. depends on the kind of clay and kind of positive ions in the water. It is inversely proportional to the conductivity of the water and independent of the kind of negative ion dissolved therein. The rapidity with which the I.P. decays appears to depend only on the grain size of the aquifer. Field trials and experiments on laboratory models give promise of useful application of the method to depths of about 350 feet.—*Authors' abstract*

- 170-102. Chetayev, D. N. Odná obratnaya zadacha teorii elektrorazvedki [The inverse problem in the electric method of exploration]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 5, p. 677-679, 1957.

A mathematical discussion of the inverse problem in electrical prospecting based on an analogy to a similar problem in aerodynamics that has already been solved.—*S. T. V.*

- 170-103. Kataoka, Hisashi, and Matsuoka, Bun'ichi. On determining the depth of buried ore body by the ground resistivity method [in Japanese with English summary]: *Butsuri-Tankō*, v. 10, no. 1, p. 1-10, 1957.

A method of determining the depth of a spherical and circular cylindrical conductor buried in a medium of uniform resistivity by successive approximations is derived. The method is also applicable to a buried cylindrical conductor with a rectangular section.—*M. C. R.*

- 170-104. Kiyono, Takeshi, Yoshizumi, Eisaburo, and Taniguchi, Keiichiro. On the vertical exploration by central induction method [in Japanese with English summary]: *Butsuri-Tankō*, v. 10, no. 1, p. 19-23, 1957.

A description of a laboratory experiment, including design problems and required characteristics, to measure the imaginary component of the secondary magnetic field.—*M. C. R.*

- 170-105. Byers, A. R. Comparison of electromagnetic geophysical prospecting methods over known sulphide zones in the Flin Flon area, Saskatchewan: *Saskatchewan Dept. Mineral Resources Dept. no. 28, 34 p.*, 1957.

Four conductive sulfide zones, previously delineated by other geophysical methods and by diamond drilling, were used to test four electromagnetic methods: an electro-galvanic method developed by B. S. Bjarnason; a vertical loop method developed by F. Doolan; a vertical loop method developed by the Sharpe Instruments Limited; a horizontal loop method developed by the Boliden Mining Company. In the first two methods the energizing equipment is stationary while the receiving coil is moved through the survey area. In the latter two methods, both the transmitter and the receiver are moved remaining a fixed distance apart.

In the Bjarnason method a-c energy of 1,000 c is directly introduced into the ground at each end of approximately 5,000 feet of cable. The amplitudes of the horizontal and vertical fields are measured. The horizontal loop method used 3,600 c energy and the amplitude of in-phase and out-of-phase components of the field are measured in terms of an arbitrary zero adjustment over homogeneous ground. The Doolan method utilizes a vertical energizing coil (1,000 c) and a rotatable receiving coil which are usually moved to successive stations maintaining an orientation of about 45° between the traverse lines and the line between the coils. The vertical angle of minimum coupling (dip) is observed. The Sharpe instrument also utilizes vertical coils and 1,000 c energy. The energizing coil is successively oriented to face each new receiving station where the dip angle is measured.

All the tested instruments proved capable of detecting the test sulfide zones. The relative sensitivity is: electromagnetic-galvanic, Sharpe, Doolan, Boliden. The Bjarnason electromagnetic-galvanic and the Boliden instrument are most suitable for exploration of large blocks of ground. The Sharpe and Doolan instruments are satisfactory for the exploration of areas composing a few claims. The Doolan instrument seems faster and more sensitive than the Sharpe.

A review of the theory of electromagnetic geophysical surveys is also included.—*W. J. D.*

170-106. Sorgenfrei, Theodor. Geoelektriske undersøgelser i Danmark og Skåne 1953 [Geoelectrical surveys in Denmark and Scania, 1953 (with English summary)]: Danmarks Geol. Undersøgelse, ser. 3, no. 32, 99 p., 1955.

Electrical resistivity surveys in Denmark and Scania (southern Sweden) during 1953, by the Wenner method, included both research and exploration projects. It was found that a combination of horizontal and vertical profiling was most suitable for Denmark, which is almost entirely covered by heterogeneous glacial deposits. Thirteen case histories are reported, five of research projects, the rest concerned with location or exploration of aquifers for rural and municipal water supply. Approximate specific resistivities of some Danish deposits are tabulated.—*D. B. V.*

170-107. Kailasam, L. N. Some results of the application of resistivity methods to problems of civil engineering, mining and ground-water in India: Geol. Survey India Bull., Ser. B, no. 3, 23 p., 1952.

Investigations reported here include surveys of the Maithon dam site, Bihar, to determine depth to bedrock; the site of a bridge across the Brahmaputra river in Assam, also to determine depth to bedrock; the Kamptee coalfield to delineate the boundary between the sandstones that included the coal-bearing formations from the metamorphic rocks (in this survey it was noted that the highest apparent resistivity was consistently observed over coal beds near the surface); and in the Purna Valley, Berar, to determine salinity of ground water.—*M. C. R.*

- 170-108. Manfredini, Antonio. Sulla misura della resistività elettrica del terreno per le prese di terra del Sincrotrone Nazionale nei pressi di Roma [On the measurement of the electrical resistivity of the terrain for the foundation of the Sincrotrone Nazionale in the vicinity of Rome]: Servizio geol. Italia Boll., v. 78, fasc. 3, p. 479-480, 1956.

Electrical measurements were made in the vicinity of the site of the national synchrotron, near Rome, to determine the resistivity of the various formations; the fill used for the foundation must have an overall resistance of 10 ohms.—*D. B. V.*

- 170-109. Manfredini, Antonio. Alcuni studi geofisici per ricerca di acqua eseguiti nell'Italia centrale e meridionale. Assistenza geotecnica alle perforazioni, a seguito dello studio geofisico della Piana della Marsiliana, Foglio 135 "Orbetello" (Italia centrale). [Some geophysical studies in the search for water made in central and southern Italy. Geotechnical aid to borings as a result of the geophysical study of the Piana della Marsiliana, Folio 135, "Orbetello" (central Italy)]: Servizio geol. Italia Boll., v. 78, fasc. 3, p. 473-474, 1956.

A program of drilling for ground water has been initiated, following electrical resistivity surveys concluded in 1954, in the Piana della Marsiliana in central Italy. Seven wells have been finished, at depths ranging between 25 and 130 m. Two cases are cited where the results did not bear out the geophysical findings: in one, the high resistivity layer was found to be due to sterile cave detritus cemented by "terra rossa" rather than to fresh water, and in the other, a layer of high resistivity near the surface proved to be travertine, not water-bearing gravel.—*D. B. V.*

- 170-110. Manfredini, Antonio. Studio geofisico della Piana delle Cinque Miglia. Foglio 153 "Agnone" (Italia centrale) [Geophysical study of the Piana delle Cinque Miglia, Folio 153, "Agnone" (central Italy)]: Servizio geol. Italia Boll., v. 78, fasc. 3, p. 475-476, 1956.

Electrical surveys made in conjunction with geologic mapping show that beneath the surface gravel, the Piana delle Cinque Miglia in central Italy is underlain by a more or less unconsolidated conglomerate from which the gravel is derived; below this is a shaly marl, probably of Miocene age, then limestone. The conglomerates should contain ground water; a more detailed geophysical survey was scheduled for the following spring for further investigation of the possibilities.—*D. B. V.*

- 170-111. Manfredini, Antonio. Due ricerche d'acqua nel centro urbano di Roma [Two investigations for water in the urban center of Rome]: Servizio geol. Italia Boll., v. 78, fasc. 3, p. 477-478, 1956.

In a well drilled in Rome at a place recommended on the basis of M. Manfredini's paper on the ground water of Rome, shallow water was first found in recent alluvium, then in a gravel aquifer 17 m thick yielding about 10 liters per second. In another well drilled on the basis of a 1952 electrical survey the upper water table was found at a depth of 50 m in a layer of gravel, as expected.—*D. B. V.*

- 170-112. Zaccara, Gaetano. Risultati preliminari sulle ricerche d'acqua effettuate nella campagna romana nel 1955 [Preliminary results on the water investigations made in the Roman countryside in 1955]: Servizio geol. Italia Boll., v. 78, fasc. 3, p. 485-488, 1956.

The search for ground water in the area from the left bank of the Tiber to the plain of Colonna in 1955 involved geological and geophysical surveys in an area of more than 250 km². A Bouguer anomaly map, based on 250 stations, showed that the general regional structure is a northwest-trending anticline that is involved in strong dislocations on the northwest and bounded on the southeast by a structural depression with large mass deficiency. The resistivity surveys, consisting of 33 vertical depth measurements at electrode spacings ranging from 10 to 1,000 m, were made partly with the Schlumberger and partly with the Wenner configuration, and showed depths to the limestone that is most suitable for exploitation of the deep ground water layer. Other smaller aquifers were found in Pliocene sands and clays and in stream gravels along the Tiber and Aniene. A second electrical survey in the Castel Porziano area, in which 19 vertical resistivity measurements were made at electrode spacings between 2 and 200 m, outlined a layer of water-bearing gravels.—*D. B. V.*

- 170-113. Manfredini, Antonio. Captazione di acque sotterranee nella Piana dei Colli per l'approvvigionamento idrico di Palermo, Foglio 249, "Palermo" [Locating the ground waters in the Piana dei Colli for the water supply of Palermo, Folio 249, "Palermo"]: Servizio geol. Italia Boll., v. 78, fasc. 3, p. 483, 1956.

Electrical surveys have delineated the zones of most active ground water circulation in the "tufo" (a soft sandstone) and of major outflow from the limestone, under the Piana dei Colli near Palermo, Italy.—*D. B. V.*

- 170-114. Beneo, E[nzo]. Risultati degli studi volti alla ricerca petrolifera in Sicilia [Results of the studies on petroleum exploration in Sicily]: Servizio geol. Italia Boll., v. 78, fasc. 1-2, p. 1-25, English translation, p. 27-50, 1956.

Petroleum exploration in Sicily must depend almost completely on geophysics; surface mapping is of no practical value because of the relative position and very different behavior under stress of the two predominant formations. Telluric and resistivity methods were chosen for reconnaissance surveys in order to take advantage of the geologic conditions: plastic clay-arenaceous rocks of low resistivity overlying a rigid substratum, mainly of limestones, of much higher resistivity. About 14,590 km², comprising most of south central and western Sicily, were covered by telluric and electrical surveys. A Bouguer map with 40-mgal contour interval was prepared from results of a gravimetric survey. The geophysical results show the presence of a deep trough in south central Sicily that extends into the Catania Plain, and that is filled with more than 7,000 m of "plastic" material.—*D. B. V.*

- 170-115. Okabe, Katsuhiko, Yamanaka, Kaoru, and Ogura, Sadahiko. Spontaneous potential measured at Besshi mine [in Japanese with English summary]: Butsuri-Tankō, v. 10, no. 1, p. 11-15, 1957.

A positive self-potential zone is observed over the main vein at the Besshi mine. Four possible causes of this anomalous condition are considered.—*M. C. R.*

- 170-116. Kaneko, Jun, Honma, Ichiro, and Sugiyama, Mitsusuke. Electrical prospecting for industrial water supply purposes at the neighborhood of the Ogaki City in Gifu Prefecture: *Geol. Survey Japan Bull.*, v. 7, no. 11, p. 25-34, 1956.

Report on a resistivity survey near Ogaki City.—*V. S. N.*

- 170-117. Kunori, Soichi, Sato, Gakuji, and Yokoyama, Hidekichi. Electrical prospecting at the Hakko copper mine, near Hirosaki City, Aomori Prefecture: *Tōhoku Kozan*, v. 3, no. 3, p. 29-36, 1957.

Self-potential and resistivity surveys of this mining area in northernmost Honshu, Japan, indicated several suitable places for test drilling near Hakko and the Kanayamazawa outcrops. The results of the self-potential and resistivity methods are also discussed in connection with the geochemical investigation of soil samples.—*V. S. N.*

- 170-118. Suyama, Junji, and Odani, Yoshitaka. The electric survey in the Taniguchi district of the Shirataki mine, Kōchi Prefecture: *Geol. Survey Japan Bull.*, v. 7, no. 10, p. 43-48, 1956.

Self-potential and resistivity measurements were made in the Taniguchi district where bedded, cupriferous-pyritic deposits occur in the Sambagawa crystalline schist. A broad self-potential anomaly (-30mV) was found over the deposit and also in some areas of the black schist zone of the Sambagawa schist.—*V. S. N.*

- 170-119. Hiersemann, Lothar, and Geier, Siegfried. Geoelektrische Prospektionsmethoden in der Sowjetunion [Geoelectrical prospecting methods in the Soviet Union]: *Bergakademie*, 9 Jahrg., no. 6, p. 317-319, 1957.

A summary of a report by a delegation from the VEB Geophysik of Leipzig to Russia to observe electrical prospecting methods there, as part of the technical and scientific cooperation between the U. S. S. R. and East Germany. Alternating current methods, being perfected under Tikhonov at the Geophysical Institute, are considered by the Russians to have the following advantages over direct: Both electrical and magnetic field strengths can be studied; different frequencies can be used (frequency profiling): possibility of penetration is better where there are poor conductors; effective sensitivity is increased; and anisotropic properties can be investigated. Induction measurements in the 50 to 16,000 c frequency range were observed at the Tandsut pyrite deposit in Armenia. Mapping was also being carried on there on the basis of long and very long wave measurements. The absorption method (electromagnetic measurements in the short wave frequency range) was being investigated by "Saborowsky" at the Geophysical Institute. Direct current profiling has been developed parallel to Flathe's work, but independent of it. Combined profiling is more widely employed in Russia than the Wenner configuration. Another much-used method is the "gradient of the mean" method. The new direct current devices KSR-2 and EAK-2, which feature automatic compensation, were inspected. In general, geophysics is encouraged and supported by the state on an inconceivably large scale. In almost every region measurements by the different methods are carried on by technicians according to a set plan; this reduces subjective errors but is expensive.—*D. B. V.*

- 170-120. Veshev, A. V., Fokin, A. F., and Ochkur, M. A. Ispol'zovaniye kombinirovannogo elektroprofilirovaniya dlya geologicheskogo kartirovaniya v krupnykh masshtabakh [Use of combined electric profiling for geologic mapping on a large scale]: Vses. nauchno-issled. inst. razved. geofiz. Voprosy rudnoy geofiz., Sbornik statey 1, p. 38-47, 1957.

Geophysical exploration methods can be very helpful in geologic mapping, especially in regions where there are only a few outcrops of ore. Two examples are given of successful use of electrical methods in the Altai Mountains. The importance of simultaneous geophysical and geologic surveying of a region, or of geophysical surveying slightly preceding the geologic work is emphasized.—S. T. V.

Malmqvist, David. An electromagnetic method of determining the electrical conductivity and magnetic permeability of drill cores. See Geophys. Abs. 170-259.

- 170-121. Elouard, P. Contribution à l'étude de la nappe des grès du Tirersioum, Mauritanie [Contribution to the study of the ground water of the Tirersioum sandstone, Mauritania]: French West Africa Direction fédérale Mines et Géologie Bull., no. 20, p. 93-104, 1957.

A summary of geologic information gained from electrical surveys and drilling on the extent and quality of the ground water in the Tirersioum sandstone in Mauritania, French West Africa.—D. B. V.

- 170-122. Blanchot, A. Les formations récentes de Mauritanie occidentale [The recent formations of western Mauritania]: French West Africa Direction fédérale Mines et Géologie Bull., no. 20, p. 9-91, 1957.

In this geological study of the young formations of western Mauritania, French West Africa, brief mention is made of geophysical surveys, mainly for ground water. Electrical resistivity surveys in the Port Coppelani area along a line 5,000 m long did not reveal the crystalline basement, which, therefore, must be at least 1,500 m deep. In the Inchiri region electrical and seismic reflection surveys showed the basement dipping regularly under the sediments, and two zones of high resistivity at Bennichab and Refaig indicated possible fresh water. The geophysical results were confirmed by drilling.—D. B. V.

- 170-123. Elouard, P. Recherches d'eau dans les formations récentes de l'Inchiri, Mauritanie [Water investigations in the recent formations of Inchiri, Mauritania]: French West Africa Direction fédérale Mines et Géologie Bull., no. 20, p. 113-128, 1957.

Resistivity surveys for ground water in the Inchiri region of Mauritania, French West Africa, showed two areas of high resistivity at Bennichab and Refaig. The slope of the basement ranged between 2 to 9 percent, averaged 3.6 percent. Two boreholes at Refaig, 12 at Bennichab, and 2 at the Toufiliit dunes were drilled and logged electrically. The extent of the fresh water lenses found at Bennichab and Toufiliit was determined with the help of the logging.—D. B. V.

- 170-124. Lefèvre, Colette, and Fournier, Hugo. Mesures et enregistrements telluriques sur le glacier d'Aletsch [Telluric measurements and records on the Aletsch glacier]: Acad. Sci. Paris Comptes Rendus, tome 244, no. 19, p. 2410-2412, 1957.

This reports on a new electrometric amplifier apparatus designed for measuring telluric currents in a medium of very high resistivity such as ice, and its operation. Tests on the Aletsch glacier in Switzerland show that apparent resistivities of the order of 10 megohms per meter can be measured satisfactorily. Thus it is now possible to apply ordinary electrical survey methods to ice, snow, or frozen soil. By the telluric method, and particularly the electrotelluric method, the nature and structure of the "ground" forming the sub-basement of glaciers can be studied; by electrical profiling, the thickness of ice-packs, frozen soils, or even ice-caps may be measured.—*D. B. V.*

ELECTRICAL LOGGING

170-125. Chombart, L. G. Reconnaissance et évaluation des formations par diagraphies électriques et nucléaires [Recognition and evaluation of formations by electrical and radioactivity logs]: *Rev. Inst. Français du Pétrole*, v. 12, no. 5, p. 543-564, 1957.

Chapter 7 of the series on recognition and evaluation of formations by electrical and radioactivity logging is devoted to general principles of interpretation of the group of diagrams constituting a log. The stages in analysis and interpretation of the log itself are fourfold: appreciation of the quality of the log and pertinent auxiliary measurements (criteria are given for evaluating each kind of log); exact correlation of all the diagrams available; dividing of a reservoir studied into macroscopically homogeneous slices; and quantitative analysis proper (homogeneous slices proper). In addition, it is absolutely necessary to compare the logging results with those obtained by other techniques. Chapter 8 gives directions for setting up exploration and development programs in general and programs including logging in particular. (See also *Geophys. Abs.* 169-110)—*D. B. V.*

170-126. Martin, M[aurice]. Possibilités actuelles de méthodes de diagraphies électriques et nucléaires [Present possibilities of the methods of electric and nuclear logs]: *Rev. Inst. Français du Pétrole*, v. 12, no. 2, p. 145-184, 1957.

Conclusion of a series on electrical and radioactivity logging. Combined use of the induction and laterolog or short normal diagram, micrologging, and the choice of a logging program are discussed. An extensive bibliography is included.—*D. B. V.*

170-127. Burge, Edgar. Selected problems in well log correlations: *Alberta Soc. Petroleum Geologists Jour.*, v. 6, no. 3, p. 38-43, 1957.

A discussion of the methods used in correlating electrical and radioactivity well logs.—*V. S. N.*

Meyer, V. A. Application of geophysical logging on polymetallic ore deposits. See *Geophys. Abs.* 170-135.

Winn, R. H. Log interpretation in heterogeneous carbonate reservoirs. See *Geophys. Abs.* 170-273.

ELECTRICAL PROPERTIES

- 170-129. Frische, Richard H., and Buttlar, Haro von. A theoretical study of induced electrical polarization: *Geophysics*, v. 22, no. 3, p. 688-706, 1957.

A mathematical solution is obtained and numerically evaluated for determining the depth to a saturated aquifer when prospecting for ground water by induced electrical polarization. In a horizontally stratified earth model consisting of a nonpolarizable overburden and an underlying, infinitely deep polarizable layer, the induced-polarization potential difference for a Wenner electrode configuration is nearly independent of the resistivity contrast. The computation agrees with results from a laboratory model tank and with a field curve. This justifies confidence in the validity of the results obtained from the model tank on earth models too complex for computation.—*Authors' abstract*

- 170-130. Buchheim, Wolfgang. Zur Theorie der galvanischen Polarisation elektrischaktiver Impragnationserze [On the theory of the galvanic polarization of electrically active disseminated ores]: *Freiberger Forschungshefte*, C 28 Geophysik, p. 5-14, 1956.

The dispersion of spherical particles in an alternating current field is calculated, as part of the development of the theory of the aftereffect of an unknown or arbitrary form on the induced polarization of disseminated ore bodies.—*D. B. V.*

- 170-131. Schrage, Ingrid. Experimentelle Untersuchungen zur induzierten galvanischen Polarisation an Sulfiderzen und graphitführenden Gesteinen [Experimental investigations on the induced galvanic polarization of sulfide ores and graphite-bearing rocks]: *Freiberger Forschungshefte*, C 28 Geophysik, p. 15-67, 1956.

Measurements were made with an alternating current bridge on several samples of sulfide ores, graphite schists, anthracite, graphite, and argillaceous clay weathering products. In comparison to the ores, the black schists showed a steeper dispersion curve of polarization capacity and higher capacities in the frequency range of 10-150 cycles per sec. Grain size was found to have a significant effect. Values obtained for compact carbonaceous masses (anthracite, graphite electrodes) were substantially the same as those for massive ores; disseminated graphite can be distinguished from ore only when it is in suspension in the rock, or, in other words, when the particle size of the ore exceeds that of the graphite by several orders of magnitude. The resistivities of the clay as well as those of ore and graphite schists depend strongly on concentration. In the clays, the dispersion of polarization capacity unexpectedly was one order of magnitude greater than that of the ores. If the calculated values of the tangent of the phase angle are plotted against frequency, the dispersion curves for clay and schists in the range of 10 to 100 (or 150) cycles per sec are clearly distinguished from those of ores by their closer dependence on frequency and lower value of $1/\omega RC$. Temperature also has an effect. With current densities below $20 \mu A/cm^2$ the range is linear in all cases. Values for the clays were dependent on current density in the range concerned.—*D. B. V.*

- 170-132. Enenshteyn, B. S. Ob udel'nykh soprotivleniyakh gornykh porod na peremennom toke [Specific resistivity of rocks to alternating current]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 401-403, 1957.

Experimental measurements of resistivity were made in regions of different geoelectric properties using alternating current of frequencies ranging from 0.3 to 300 cycles per sec and a standard electrode arrangement. Within the range of frequencies used the specific electric resistivity of the ground did not vary more than ± 5 percent and is very near that determined for direct current. The distance over which the measurements were made ranged from 30 to 100 meters.—S. T. V.

EXPLORATION SUMMARIES AND STATISTICS

- 170-133. Westphal, W. H. Geologic considerations in the application of geophysics to mining exploration: Mines Mag., v. 47, no. 6, p. 49-50, and 56, 1957.

A review of the current status and problems of mining geophysics, and a discussion of the various physical properties of ores and rocks that influence measurement of physical quantities in geophysical prospecting.—L. C. P.

- 170-134. Lafargues, Pierre. Possibilités actuelles de l'application des techniques géophysiques à la recherche minière en mines métalliques [Present possibilities of the application of geophysical techniques to ore exploration in metal mines]: Chronique des Mines d'Outre-Mer, 25^e année, no. 252, p. 193-206, 1957.

A brief review of the principles and techniques of the magnetic, aeromagnetic, gravimetric (including airborne), self-potential, resistivity, induced polarization, electromagnetic (including airborne), and airborne scintillometer methods, as applied to exploration for metallic ores.—D. B. V.

- 170-135. Meyer, V. A. Primeneniye karottazha na polimetallicheskiye mestorozhdeniyakh [Application of geophysical logging on polymetallic ore deposits]: Vses. nauchno-issled. inst. geofiz. Voprosy rudnoy geofiz., Sbornik statey 1, p. 48-61, 1957.

Electrical resistivity, magnetic susceptibility, spontaneous potential, and radioactivity logging make it possible to obtain more details on the geologic column and aid in exploration for polymetallic ore deposits. Electrical methods can be used to determine the boundaries not only of thick ore layers but also of thin streaks of sulfides and disseminated ore veins. By density logging it is possible to separate graphitized rocks. Methods of determining mineral composition of sulfide ores seem to be feasible. Numerous graphs and profiles illustrate the results obtained by different methods.—S. T. V.

- 170-136. Bennett, R. F. From the bottom up: Am Assoc. Petroleum Geologists Bull., v. 41, no. 7, p. 1409-1415, 1957.

A discussion of the present status of oil exploration, including a review of recent advances in exploration geophysics.—L. C. P.

- 170-137. Tuominen, Heikki V., Mikkola, Toivo, and Simola, Torsti. Exploration for ore in the Orijarvi region, Finland: Canadian Min. Metall. Bull., v. 49, no. 533, p. 641-643, 1956.

Magnetic, electromagnetic, electrical, gravity, and biogeochemical methods are used, in conjunction with geologic mapping, to explore for ore in the Orijarvi region, Finland. Comparison of geologic and geophysical maps provide information on favorable locations for ore which apparently occurs in a stratigraphic horizon characterized by marble and skarn and forms cores of folds or is squeezed along axial planes or faults.—*L. C. P.*

- 170-138. Bujalow, N. I. Such- und Erkundungsarbeiten auf Erdöl und Erdgas in der Deutschen Demokratischen Republik [Reports on the exploration and exploitation of petroleum and natural gas in the Deutschen Demokratischen Republik]: Zeitschr, angew. Geologie, Band 3, Heft 4, p. 153-158, 1957.

In this review of oil and gas exploration and exploitation in East Germany, it is mentioned that recent geophysical exploration has disclosed more than 100 possible structures. It is recommended that exploration of new structures be continued, particularly in Mecklenburg and the Altmark, with regional gravimetric surveys followed by detailed seismic work. Known structures in the northeastern part of the republic as far as the Polish border should be further investigated geologically and geophysically, with borings to aid interpretation of data. The importance of well logging in exploitation is also stressed.—*D. B. V.*

- 170-139. Moiseyenko, F. S. Opyt geologicheskoy s'emki v Nerchinsko-Zavodskom rayone Vostochnogo Zabaykal'ya s ispol'zovaniyem geofizicheskikh dannyykh [Experiences gained in geologic surveying of the district of Nerchinskiy Zavod in the Eastern Transbaykal region using geophysical data]: Vses. nauchno-issled. inst. razved. geofiz. Voprosy rudnoy geofiz, Sbornik statey 1, p. 20-37, 1957.

This is the report on extensive geophysical surveys made in the Nerchinskiy Zavod district, where various metal ores which have been mined for more than 200 years but where outcrops of ores are rare. Geophysical investigations, chiefly electrical and magnetic, provided valuable additional material for a new 1:50,000 geologic map of the area.—*S. T. V.*

GENERAL

- 170-140. Brauch, Wolfgang. Zur Dokumentation und Klassifikation der Geophysik [On the documentation and classification of geophysics]: Gerlands Beitr. Geophysik, Band 66, Heft 2, p. 151-177, 1957.

A new system of classifying geophysical papers is proposed, no existing system being considered adequate. The two main headings are "formal categories" and "objective categories"; where required, each division and subdivision of the objective categories can be further subdivided into the formal categories. The principal headings under the objective categories are "pure geophysics" (general; evolution, constitution, structure; motion, gravity, figure; seismics; geomagnetism, earth-currents, ionosphere; meteorology, climatology; oceanography) and "applied geophysics" (general; physical properties of rocks; gravitational

methods; seismic methods; magnetic methods; electrical methods (except logging); radioactivity and thermal methods (except logging); geophysical well logging; other methods). A punchcard method of filing is suggested for easy mechanical selection of papers according to any combination of subjects.—*D. B. V.*

- 170-141. Melton, Ben S., and Karr, Philip R. Polarity coincidence scheme for revealing signal coherence: *Geophysics*, v. 22, no. 3, p. 553-564, 1957.

A simple statistical procedure, based on multiple coincidence of field polarities as indicated by several receptors, offers a criterion of the existence of a signal below the general noise level. As an example, with six receptors in a field where there is a sine wave signal ten decibels below the noise level, there will be twice the number of coincidences that would be obtained for the noise alone. A scheme is shown to illustrate how an electrical system can perform the analysis and present the results continuously.—*Authors' abstract*

- 170-142. Melton, Ben S., and Bailey, Leslie F. Multiple signal correlators: *Geophysics*, v. 22, no. 3, p. 565-588, 1957.

Methods of correlation of any number of input functions or signals to be compared are discussed. It is shown that correlation values can be obtained from any one of several arithmetic processes which measure the degree of similarity of the inputs, and that these processes can be mechanized. Included are a simple addition, a sign-coincidence scheme and two processes based on analysis of variance. The discussion of analysis of variance procedures as applied to signals shows that the answers can be interpreted in terms of statistical significance, that measurements of coherent signal power can be made and that the accuracy of such measurements is greatly improved as the number of input signals is increased. Signal-to-noise ratio is shown to be uniquely related to statistical significance, and signal detectability is plotted as a function of number of inputs and signal duration. Several means of presentation of data are suggested and illustrated.—*Authors' abstract*

- 170-143. Borisevich, E. S. Vysokochastotnyye ramochnyye gal'vanometry [High frequency galvanometers with chassis]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 4, p. 479-492, 1957.

A detailed description is given of a new type of high-frequency galvanometer which has its electrical system built on a chassis. The instrument has a high natural frequency and is specially adapted for use in construction of oscillographs. Its unique feature is the use of the chassis and a continuously stretched spring. The differential equation of the moving system is analyzed and many details of the new galvanometer are given.—*S. T. V.*

- 170-144. Tárczy-Hornoch, Antal. Über die Genauigkeit von aus geophysikalischen Messungen errechneten Werten [On the accuracy of values calculated from geophysical measurements]: *Freiberger Forschungshefte*, C 29 *Geophysik*, p. 47-61, 1956.

This is a mathematical analysis of the individual sources of measurement error entering into calculation of gravitational acceleration by means of pendulum measurements, determination of average seismic wave velocities in reflection work, and determination of apparent resistivity in the Wenner and Schlumberger methods.—*D. B. V.*

GEODESY

- 170-145. Bragard, L[ucien]. Courbure moyenne des sections principales et gradient vertical de la pesanteur en un point d'un ellipsoïde de révolution [Mean curvature of the principal sections and vertical gradient of gravity at a point on an ellipsoid of revolution]: Soc. Royale Sciences Liège Bull., 26^e année, no. 3, p. 136-141, 1957.

First the mean curvature of the principal sections at a point on an ellipsoid of revolution is expressed as a function of the co-latitude Θ , of mean radius a_m , and of flattening e , to the fourth order. In the case of the international ellipsoid of revolution used in geodesy, the numerical formula which enters into the calculation of a constant of the geoid is obtained. It is expressed finally as a function of equatorial radius a . Then the numerical formula is obtained which enters into the determination of the geoid by the method of differences in mean curvatures of the principal sections. Using this last formula and that for gravity previously established to the fourth order, the vertical gradient of gravity is expressed at a point on the international ellipsoid. This numerical formula enters into the determination of the geoid by the method of differences in vertical gradients of gravity.—*Author's summary, D. B. V.*

- 170-146. Levallois, Jean-Jacques. Sur la détermination du géoïde par des mesures gravimétriques sur la surface topographique [On the determination of the geoid by gravity measurements on the topographic surface]: Acad. Sci. Paris Comptes Rendus, tome 244, no. 20, p. 2479-2482, 1957.

An integro-differential equation (inspired by the ideas of Molodenskiy, see Geophys. Abs. 134-10228) integrable on the topographic surface of the earth is derived, by means of which the form of co-geoid can be calculated from the observed gravity values compared with the theoretical gravity values on any reference model.—*D. B. V.*

- 170-147. Lieberman, Harry A. An investigation of the geoid in Europe: Bull. géod., no. 37, p. 1-11, 1955.

The present orientation of the International ellipsoid in Europe determined in the adjustment of the central European net would not be greatly changed by using astro-geodetic data throughout Europe. A change of 3 meters in elevation and less than a second of arc of deflection in either the direction of the meridian or the prime vertical at the arbitrary origin is indicated.—*M. C. R.*

GEOTECTONICS

- 170-148. Chain, W. E. Der gegenwartige Stand der Geotektonik im Ausland [The present state of geotectonics in other countries]: Zeitschr. angew. Geologie, Band 3, Heft 2/3, p. 123-129, 1957.

A German version of a paper in Sovetskaya Geologiya, v. 48, 1955, reviewing the status of geotectonic work in different countries and comparing with Russia. It is concluded that the Russians are ahead in problems concerning the principles of development and historic types of geosynclines and more so in regard to platforms and their development; development of the crust in gen-

eral; theoretical fundamentals of structural history (facies, thicknesses, discordances); the "borderlands" hypothesis; concept of phases of formation of folds; the "Deckentheorie"; the introduction of the concept of inversion in the development of geosynclines and investigations of structural disharmony; a genetic system of folds; mechanics of folding; and recent tectonics. They are considered about equal with regard to the relation of magmatism to tectonics, and of tectonics to sedimentation. They are behind on structure of the oceans, relation between geophysics and geotectonics, and experimental tectonics (particularly the behavior of rocks under high pressures), and formulation of geotectonic hypotheses. Russian work is found to be little known in the foreign literature. It is suggested that Russian authors publish more frequently in foreign journals, and a more systematic exchange of scientific information is urged.—*D. B. V.*

- 170-149. Scheidegger, A[drian] E[ugen]. Rheology of the earth: The basic problem of geodynamics: Canadian Jour. Physics, v. 35, no. 4, p. 383-397, 1957.

A discussion is given of the data which are available to provide information on the rheological behavior of the Earth's mantle and crust. It is shown that a fundamental distinction has to be made between stress durations that are "short" (up to 4 hours) "intermediate" (4 hours to 15,000 years), and "long" (longer than 15,000 years). For short durations, the behavior of the Earth is well known from the results of seismological investigations. However, these results should not be applied directly to the longer time durations. For intermediate time durations, the Earth shows an elastic aftereffect. One obtains a value for the (Kelvin) viscosity if it is assumed that the damping of the variation of latitude is caused by a Kelvin effect. The same (Kelvin) viscosity is arrived at if the strain rebound characteristics of earthquake aftershock sequences are also interpreted in terms of an elastic aftereffect. For stresses of long duration, some information may be obtained from the uplift of Fennoscandia. It appears that viscous creep is the prevailing phenomenon. If this information is combined with some further considerations, indications are that the Earth behaves like a Bingham body. Then, the fact that orogenetic phenomena are concentrated in narrow bands may be due to the existence of solutions of the Bingham equation exhibiting rheological instability.—*Author's abstract*

- 170-150. Carey, S. Warren. El concepto de oroclinal en geotectonica [The orocline concept in geotectonics]: Inst. geol. min. España notas y comunicaciones, no. 45, p. 217-271, 1957.

A Spanish translation by J. M. Rios of a paper originally published in the Papers and Proceedings of the Royal Society of Tasmania, v. 89, 1955 (see Geophys. Abs. 163-201).—*D. B. V.*

- 170-151. Sonder, Richard A. Gedanken zur theoretischen Geotektonik [Ideas on theoretical geotectonics]: Geotektonisches Symposium zu Ehren von Hans Stille, Stuttgart, Kommissions-Verlag von Ferdinand Enke, p. 381-395, 1956.

A discussion of the philosophical aspects of geotectonics. Theories fall into two groups, fundamental theories and "geologic-tectonic" theses. The former are concerned with causes, forces, and sources of energy. Three of these—contraction, "Unterströmung" and continental drift—are compared from various stand-

points and the first round most acceptable. Geotectonic theses are concerned with classification or with principles; they are based on geological observations of the crust, seek to describe as accurately as possible the course of and laws governing the earth's tectonic history; their degree of probability can sometimes be demonstrated statistically. The theoretical tectonophysicist confronts the fundamental theories with the various geotectonic theses to arrive at the best approximation of the truth.—*D. B. V.*

- 170-152. de Sitter, L. U. Elastic or plastic buckling of the earth's crust: *Leidse Geol. Meded.*, deel 20, p. 171-176, 1955.

The excessive stress needed to produce elastic buckling in an unlayered crust of 30 km thickness would crush the crustal material. However, a model experiment indicates that the initial elastic strain in the earth's crust can result in shear planes parallel to the earth's surface. The existence of the shear planes would greatly reduce the buckling strength of the crust.

The proposed root buckle of the Alps, as deduced from the observed gravity anomaly, is too small to account for the estimated shortening of the earth's crust in the area. However, a preceding geosynclinal stretching and thinning of the crust in the area of the buckle, and the partial melting and removal of the bottom of the crust would reduce the size of the buckle. Also, more recent views on the nappe structures suggest that estimates of the crustal shortening are too large. These considerations bring the proposed root structure and the observed gravity anomaly into better accord. Other postulates of the buckling hypothesis are reviewed in light of new evidence and concepts.—*M. F. K.*

- 170-153. Bucher, W[alter] H. Modellversuche und Gedanken über das Wesen der Orogenese [Model experiments and ideas on the mode of orogenesis]: *Geotektonisches Symposium zu Ehren von Hans Stille*, Stuttgart, Kommissions-Verlag von Ferdinand Enke, p. 396-410, 1956.

A hypothesis of the mode of orogenesis is outlined, based on observations and deductions from model experiments on viscosity, deformation, and the like. Since late Mesozoic time, shrinkage due to secular cooling has produced oblique zones of fracture and weakness in the crust between depths of 100 and 700 km (evidenced at the surface by earthquakes). Over these zones the stereosphere is pressed down to form geosynclines. Through tension cracks at the base of such sags, ultrabasic and basic material easily penetrates the geosyncline; this is the "initial magmatism" that precedes orogenesis. In the meantime, deep in the zones of fracture and weakness there begins the escape and rise of superheated steam accompanied by volatiles; these reach the lower surface of the stereosphere and penetrate it through the cracks caused by the downbuckling, and lead in part to granitization, in part to melting. The introduction of elements from depth is characteristic of the magmatism of orogenic zones. Increase of heat and chemical changes lower the viscosity of the zones concerned; predominating pressure causes structural changes and vertical uplift, which near the surface produces typical folded mountains under the influence of gravity. The counterplay of heat conduction and release of tension may lead to a rhythm which may be the key to orogenic cycles. Tectonic development independent of previous structures, such as that occurring after the Algonkian and after the Permian, means that new zones of fracture and weakness have developed independently of previous zones.—*D. B. V.*

- 170-154. Bülow, Kurd v[on]. Selenotektonik und Geotektonik [Selenotectonics and geotectonics]: Geotektonisches Symposium zu Ehren von Hans Stille, Stuttgart, Kommissions-Verlag von Ferdinand Enke, p. 45-51, 1956.

Model experiments and study of the crust of the moon and of the fundamental structure of the earth's crust all indicate that vertical currents determine the distribution of land elements and the course of the major lineaments. Continued vertical currents, with horizontal branches, keep these major elements active, force the sedimentary cover to react like a sheet of ice on troubled water. Vertical tension is thus the ultimate cause of geosyncline formation and folding. In the distribution of land elements a general planetary tendency is manifest; in the moon the original state is preserved, in the earth it shows, still mobile, through the sediment skin.—*D. B. V.*

- 170-155. Gutenberg, B[eno]. Verschiebung der Kontinente, eine kritische Betrachtung [Continental drift, a critical examination]: Geotektonisches Symposium zu Ehren von Hans Stille, Stuttgart, Kommissions-Verlag von Ferdinand Enke, p. 411-421, 1956.

Results of geological, geodetic and geophysical investigations indicate that at least in several areas surrounding the Pacific Ocean displacements of parts of continents relative to each other at a speed of roughly 1 mile in 100,000 years have occurred during recent geological periods and that such movements still continue. The continents surrounding the Pacific seem to have moved prevalently towards the Pacific for long periods during the past, but at present motions tangential to the Pacific prevail in many sectors. There is no agreement yet whether or not continental blocks have drifted thousands of kilometers relative to the earth's poles of rotation or similarly relative to the average position of the magnetic poles. Nearly all of those who believe that such large movements have occurred came to the conclusion that the north pole of rotation as well as the magnetic north pole have moved during the past several hundred million years from somewhere in the central Pacific, perhaps roughly 2,000 km north of the present equator, to their present position. This could have been the result of a movement of the earth's axis relative to the whole mantle. On the other hand, the viscosity (corresponding to a time of relaxation of roughly 10,000 years) is not too great to permit large blocks with a thickness of roughly 100 km to move relative to the main portion of the earth's mantle as a result of (viscous) flow and thus cause apparent large polar movements. The present structure of the earth's crust could well be a consequence of a drifting apart of continental blocks forming originally a single continental block. In discussions of this and other tectonic problems the possibility must be considered that the Mohorovičić discontinuity, which is taken as the lower boundary of the crust, is the result of a phase change. In this case, appreciable changes in the depth of the discontinuity could be produced under favorable circumstances in regions where the temperature of the crust is changing even by a small amount. The history of the earth's crust is much more complicated than it is usually assumed. Many more observations of various kinds are needed before hypotheses concerning the development of the earth's crust can be considered trustworthy.—*Author's abstract*

Lyustikh, Ye. N. On convection in the earth's mantle in accordance with the computations of Pekeris. See Geophys. Abs. 170-207.

- 170-156. Havemann, Hans. Transgression-Regression und Konvektion [Transgression-regression and convection]: *Geologie, Jahrg. 6, Heft 2*, p. 123-140, 1957.

This is an investigation of the possibility of a relationship between major cycles of world-wide transgression and regression, plus tectogenesis, and periodic convection in the earth's mantle, taking as a point of departure the expansion and contraction due to periodic convection on a planetary scale, together with the difference in character between continents and ocean basins and its effect of subcrustal convection. The theories of Joly, Hales, and Vening Meinesz are discussed critically and found inadequate to explain the present observed phenomena (especially of seismology and gravimetry) around the Pacific borders. Havemann suggests that endogene changes of relief in the crust are not merely indirect results of convection, but stem directly from the fact that expansion and contraction of the ocean floors (particularly the Pacific), which lose heat more rapidly and are less radioactive, are of larger amplitude than that of the well-shielded and more radioactive continents. The faster rising and sinking of the ocean floors with respect to the slower pulsation of the continents thus brings about the global, large-scale transgressions and regressions. More local exogene and endogene changes of relief, particularly of continents, lead to second order transgressions and regressions shorter in period or aperiodic. The difference in expansion-contraction amplitude between continents and oceans leads to a cell structure in the earth in which the size and shape of the units, other things being equal, depend only on the thickness of the layer and its radius of curvature. Comparisons are drawn between crustal phenomena, evolution, and internal constitution of the moon, Mars, and earth. Finally, the last broad major cycle of earth history, the time since the Variscic, is outlined in the light of the new hypothesis.—D. B. V.

- 170-157. Wegmann, E. Tectonique vivante, dénudation et phénomènes connexes [Active tectonics, denudation and related phenomena]: *Rev. Géographie phys. et Géologie dynamique, sér. 2, v. 1, fasc. 1*, p. 3-15, 1957.

Methods of determining mean and real rates of deformation in the crust are examined briefly. Application of the principle of interference—between denudation and deformation (uplift)—is expounded. The three principal cases are that where rate of uplift exceeds rate of denudation (active erosion), that where they are approximately equal (little change in topography if bedrock does not change), and that where denudation exceeds uplift (mature to old topography). Several models are presented. Calculations for the Alps give 4 to 8 cm per century for rate of uplift, 3.3 cm per century for mean rate of denudation (figures are minimums). Variations in rate (reflecting isostatic compensation, sea level fluctuations, plastic flow deep in earth, among other reasons) and some of their repercussions on the study of movements in different tectonic stages show the importance of measuring speed of deformations. The old question of whether tectonic movements are continuous or discontinuous is discussed in the light of this study; it is shown that gaps in the lithologic record need not mean cessation of movement, merely changes in manner and direction of displacements relative to one another.—D. B. V.

- Honda, Hirokichi, Masatsuka, Akira, and Emura, Kinya. On the mechanism of the earthquakes and the stresses producing them in Japan and its vicinity (Second paper). See *Geophys. Abs.* 170-55.

- 170-158. Shepard, Francis P. Northward continuation of the San Andreas fault: *Seismol. Soc. America Bull.*, v. 47, no. 3, p. 263-266, 1957.

The northward continuation of the San Andreas fault probably makes a westward bend along the Gorda escarpment somewhat like the trend changes to the south. The topographic expression in the area is consistent with the large right lateral shift that is characteristic of the San Andreas fault and the amount of displacement indicated is not out of line with the amount of displacement along the San Andreas and adjacent faults in southern California.—*M. C. R.*

- 170-159. Alberding, H. Application of principles of wrench-fault tectonics of Moody and Hill to northern South America: *Geol. Soc. America Bull.*, v. 68, no. 6, p. 785-790, 1957.

The principles of wrench-fault tectonics expressed by Moody and Hill (see *Geophys. Abs.* 167-122) have been applied to northern Venezuela, Trinidad, and northeastern Colombia. The evidence suggests movements along the southern edge of the Caribbean in South America comparable and complementary to those movements which occurred in the Greater Antilles and Central America in the northern part of the Caribbean.—*M. C. R.*

- 170-160. Glangeaud, Louis. Corrélation chronologique des phénomènes géodynamiques dans les Alpes, l'Apennin et l'Atlas nordafricain [Chronological correlation of geodynamic phenomena in the Alps, the Apennines, and the North African Atlas]: *Soc. géol. France Bull.*, tome 6, fasc. 7-9, p. 867-891, 1956.

Comparison of chronodiagrams for the peri-Mediterranean Alpine ranges leads to a new hypothesis of the evolution of the whole Mesogean tectogene, based on contraction of the geosyncline. Beginning in middle Eocene, the drawing together of the peri-Mesogean blocks produced biliminary phenomena completely different from the monoliminary phenomena of the Mesozoic. During the upper Eocene, the plastic eugeosynclinal sediments were compressed and then "ejected" to form a more resistant core. Then the European and African borders were deformed and shattered. The amount of contraction at each point was a function of width of the eugeosyncline in that area and of the form and direction of pressure from the edges of the cratons. The main orogenic paroxysms (Oligocene) were synchronous all along the Mesogee. Post-paroxysmal (Miocene) glide-folding of the cover down the flanks of the uplifted mass produced nappes varying greatly in detail but belonging to two main groups, "epidermal" and "epiglyptic". Plio-Quaternary movements resulted in the continental flexures and folding in Algeria and the Po plain. Tertiary volcanism occurred in the post-paroxysmal stage of relaxation of pressure. Some earthquakes seem to be related to pre-Miocene structures but most are associated with Plio-Quaternary deformation. Gravity data from France, Italy, and North Africa were used to aid the correlations. An extensive bibliography is included.—*D. B. V.*

GLACIERS

- 170-161. Bull, C. Observations in north Greenland relating to theories of the properties of ice: *Jour. Glaciology*, v. 3, no. 21, p. 67-72, 1957.

A study was made of the surface slope and thickness of the ice sheet in north Greenland to test Nye's formula by which the maximum surface slope at a point on an ice sheet is related to the thickness at that point. In this formula

it is assumed that the behavior of ice in glaciers and ice sheets is a problem in plasticity. Comparison of thicknesses determined by seismic and gravity methods with thicknesses calculated from Nye's formula showed the actual thicknesses to be much less than those predicted from Nye. The stress: strain relationship for ice in north Greenland is too different from a perfect plastic material for the results of the plasticity theory to be applied directly. Differences between shear stresses in north and south Greenland probably cannot be explained solely by different rates of movement but are at least partly due to the presence of bottom melting in the north.—*V. S. N.*

- 170-162. Weertman, J. Deformation of floating ice shelves: *Jour. Glaciology*, v. 3, no. 21, p. 38-42, 1957.

An analysis is made of the problem of the creep of floating ice shelves by using Glen's creep law for ice and Nye's relation of steady-state creep (the analogue of the Lévy-Mises relation in plasticity theory). The solution is equivalent to the solution of the problem of a weightless material being compressed by frictionless plates. It is established that creep rate in the shelf far from the edges is constant from top to bottom and that a shrinking shelf cannot exist. Good agreement is found in comparison between the observed creep rate of shelf ice at Maudheim in the Antarctic and that predicted from the results of creep tests by Glen.—*V. S. N.*

Lefèvre, Colette, and Fournier, Hugo. Telluric measurements and records on the Aletsch glacier. See *Geophys. Abs.* 170-124.

- 170-163. Haefeli, R. Notes on the formation of ogives as pressure waves: *Jour. Glaciology*, v. 3, no. 31, p. 27-29, 1957.

Observation and velocity measurements on Mt. Collon glacier show that during the time of ablation large local increases in velocity can arise, probably because of the increased amount of melt water and the resulting reduction of friction on the glacier face. These large local increases in velocity are taken to be the cause of the formation of pressure waves or ogives.—*V. S. N.*

- 170-164. Weertman, J. On the sliding of glaciers: *Jour. Glaciology*, v. 3, no. 21, p. 33-38, 1957.

A model is proposed to explain the sliding of any glacier whose bottom surface is at the pressure melting point. Two mechanisms are considered. One is pressure melting and the other is creep rate enhancement through stress concentrations. Neither of the mechanisms operating alone is sufficient to explain sliding. If both mechanisms operate together appreciable sliding can occur.—*Author's abstract*

GRAVITY

- 170-165. Liebold, Rudolf. Die Erscheinungen der Stabilität und Instabilität der Mathieschen Differentialgleichung, vorgeführt an einem physikalischen Pendel [The phenomena of stability and instability of the Mathieu differential equation, demonstrated by a physical pendulum]: *Freiberger Forschungshefte*, O 29 Geophysik, p. 33-46, 1956.

The Mathieu differential equation is applied to a pendulum whose center of gravity is directly above the point of suspension so that it is in unstable equilibrium. (Every measuring instrument indicator that is not pivoted exactly on its center of gravity is comparable to this example.) The formula derived for

sensitivity of a measuring system is $da/dg=2h/g \times (x^2-2)/(x^2+2) \times x/\sqrt{(x^2+2-2hx)(x^2+2+2hx)}$ where x =ratio of acceleration produced to earth's acceleration, h =a given parameter, a =angle of deflection of indicator, and g =gravity acceleration.—*D. B. V.*

- 170-166. Arnold, Kurt. Eine durch Oberflächenwerte bestimmte Reihenentwicklung für die Tangente der Lotlinie [An expansion series for tangents to the plumb line, determined from surface values]: *Gerlands Beitr. Geophysik*, Band 66, Heft 2, p. 89-101, 1957.

An expansion series for the variation of the tangential unitary vector along a plumb line (force line of the earth's gravitational field) is developed according to the powers of the length of the arc of the plumb line (Z), ending after the third power. The coefficients in the expansion series are obtained from the values of the horizontal gravity gradient and mean curvature of the equipotential surface, determined at the earth's surface. For $Z=3,000$ m, the error resulting from the approximations introduced into the expansion series is less than $0.16''$.—*D. B. V.*

Levallois, Jean-Jacques. On the determination of the geoid by gravity measurements on the topographic surface. See *Geophys. Abs.* 170-146.

- 170-167. Romanyuk, V. A. Opredeleniye sily tyazhesti na more mayatnikovym sposobom I. [Determination of gravity at sea with a pendulum, Part I]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 3, p. 341-350, 1957.

A rigorous analysis based on the general theorems of theoretical mechanics and mathematics of the motion of a pendulum attached to a support, moving with six degrees of freedom. Vening Meinesz, who first investigated this theory, replaced the precise equation of motion by an approximate one, omitting terms higher than second order. Romanyuk includes terms up to the fourth order.—*S. T. V.*

- 170-168. Romanyuk, V. A. Opredeleniye sily tyazhesti na more mayatnikovym sposobom. II [Determination of gravity at sea by the pendulum method, Part II]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 4, p. 458-470, 1957.

An evaluation is made of the effect of disturbing the differential equation of a fictitious pendulum on its average period. Second-order corrections are computed for the disturbing effect of tilting the support and linear accelerations. The final results are compared with those obtained by Vening Meinesz, Brown, and Zongolovich. Corrections caused by the omission of disturbing terms of different frequencies were computed and the last term which has a period of 320 sec was found to have little effect on the final result, so that to go to still slower disturbing terms would decrease the error very little. Another possibility of attaining greater precision of the measurements is to continue the individual observation over a longer interval of time.—*S. T. V.*

- 170-169. Kaula, William M. Accuracy of gravimetrically computed deflections of the vertical: *Am. Geophys. Union Trans.*, v. 38, no. 3, p. 297-305, 1957.

The root-mean-square values of the mean anomalies of squares of a given size, and the correlation between mean anomalies of squares over given dis-

tances are used to determine what uncertainty should normally be expected in the gravimetrically computed deflection of the vertical due to neglect of gravity data beyond a given radius; the error of representation of anomalies for squares of different size is used to determine what uncertainty should be expected when a given number of stations are observed out to any given radius, beyond which there are either no stations or a uniform distribution of stations. For an assumed root-mean-square point anomaly of ± 28 mgal, the root-mean-square modulus of the deflection is $6.0''$. The root-mean-square effects of anomalies beyond given radii were, for example: $1.2''$ beyond 3,000 km, $3.3''$ beyond 500 km. Error in elevation of the geoid computed, in a similar way, is ± 21.3 km. Errors due to error of representation of observed anomalies are shown graphically. For example, 200 stations out to 1,000 km will give a root-mean-square error of $2.7''$; 50 stations, $3.0''$. Corresponding figures for 3,000 km are $1.6''$ and $2.5''$.—*M. C. R.*

- 170-170. Hergerdt, M. Ein Vergleich von nach verschiedenen Näherungsformeln berechneten Werten von U_{zzz} für theoretische und praktische Beispiele [A comparison of calculated values of U_{zzz} according to different approximate formulas for theoretical and practical examples]: *Gerlands Beitr. Geophysik*, Band 66, Heft 1, p. 4-22, 1957.

In the present paper will be given a survey on the theoretical values of the third vertical derivative of the gravity-potential (U_{zzz}) above assumed simple forms of mass. From the calculated gravity-fields of these masses will be computed also U_{zzz} with the help of known formulas of approximation using different net-widths. The approximated maximal values are compared and—for sphere and cylinder—expressed in percents of the theoretical maximal value. At a practical example—computed in different manners—will be tried a method to find the depth of a disturbing mass.—*Author's abstract*

- 170-171. Tribalto, G[iuseppe], and Amadei, G[aetano]. Anomalie residue e derivate seconde nella interpretazione dei dati gravimetrici [Residual anomalies and second derivatives in the interpretation of gravity data]: *Annali Geofisica*, v. 9, no. 2, p. 167-177, 1956.

A discussion of the determination of residual gravity by the following methods: average value computed by means of regular polygons inscribed in circles of given radius; least squares; second derivative of the vertical component by the Elkins and Rosenbach formulas. Results are illustrated by a series of maps drawn from the Bouguer anomaly map obtained in a survey of the Pianura Pontina, Rome, by the Servizio Geologico d'Italia.—*M. C. R.*

- 170-172. Rosenbach, Otto. Prinzipielle Bemerkungen zu Theorie und Praxis der Methode der zweiten Ableitung bei der Interpretation gravimetrischer Messergebnisse [Basic observations on the theory and practice of the second derivative method in the interpretations of gravity data]: *Geophys. Prosp.*, v. 5, no. 2, p. 165-192, 1957.

The first part of the paper deals with theoretical considerations concerning the arithmetic mean of gravity values and its use with regard to the derivation of approximation formulae for the second derivative. In order to calculate the second derivative in practice the arithmetic mean $g(r)$ of a continuum of grav-

ity values on a circle of radius r is approximated by a Taylor polynomial and then replaced by the arithmetic mean $\bar{g}_n(r)$ of n discrete gravity values. Because of the invariance of $\bar{g}(r)$ with regard to rotations of the coordinate system in the horizontal datum plane there exists a lower limit for the number n ; this lower limit depends on the degree of the Taylor polynomial used in the formula for g_{ss} .

The general results of the first part yield routine formulae for the special case of a regular hexagonal grid; these formulae are given and discussed in the second part of the paper. Three formulae are applied to the gravity data of the Los Angeles Basin. Some remarks concerning the comparability of different approximation formulae and some hints with regard to routine calculations conclude the paper.—*Author's abstract*

- 170-173. Bulakh, Ye. G. Yesheche odin criteriy dlya proverki interpretatsiy gravitatsionnykh anomalii [One more criterion for checking the interpretation of gravitational anomalies]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 4, p. 522, 1957.

In two-dimensional space let S be a region filled with a mass of an excess density $\sigma(x, z)$. The potential V , produced by this mass at points outside S is 2

$$\iint \sigma(x, z) \ln(1/R) dz,$$

where $R = \sqrt{(\xi - x)^2 + (\zeta - z)^2}$, and k is the gravitational constant. Taking a straight line outside S and two points, a and b , on it the expression for V , valid for the entire space outside of S , can be applied for the line ab . Thus after some transformations, the equation

$$\int_a^b V \xi \zeta d\xi = 2k(b-a) \iint_S \sigma \frac{\sin \phi_2 - \phi_1}{R(a)R(b)}$$

is obtained. This equation can be used as the criterion of the assumed region S and the density σ .—*S. T. V.*

- 170-174. Ivanhoe, L. F. Chart to check elevation factor effects on gravity anomalies: Geophysics, v. 22, no. 3, p. 643-645, 1957.

Presents a graph from which the amount that a local anomaly would be changed by using a different elevation factor can be determined.—*M. C. R.*

- 170-175. Bemmelen, R. W. van. Physical versus physico-chemical interpretation of gravity data: Geologie en Mijnbouw, 19^e jaarg., no. 6, p. 223-224, 1957.

Van Bemmelen defends his physico-chemical approach to gravity interpretation criticized by Collette (see Geophys. Abs. 169-162).—*D. B. V.*

- 170-176. Hospers, J. Gravity and crustal shortening (a reply to B. J. Collette): Geologie en Mijnbouw, 19^e jaarg., no. 6, p. 221-223, 1957.

Hospers defends his methods and conclusions criticized by Collette (see Geophys. Abs. 168-200 and 169-162).—*D. B. V.*

- 170-177. Rische, Hans. Dichtebestimmungen in Gesteinsverband durch Gravimeter und Drehwaagemessungen unter Tage [Density determinations in the rock assemblage underground by means of gravimeter and torsion balance measurements]: Freiburger Forschungshefte, C 35 Geophysik, 83 p., 1957.

The determination of density underground by the vertical gravity method is treated in detail (theory, execution, reduction, accuracy, and interpretation of results), and the method proposed by Meisser using the torsion balance is described fully for the first time (principles, procedure, accuracy, and limitations). The accuracy of the gravimeter method is generally higher; the gravimeter measurements are limited by the vertical gradients of anomalies, the torsion balance measurements by the unpredictable effect of disturbing masses in the direct vicinity of the station. The density of the Freiberg gneiss, determined on a laboratory sample, is $2.694 \pm 0.001 \text{ gcm}^{-3}$; by the gravimeter method underground, $2.692 \pm 0.006 \text{ gcm}^{-3}$; and by the torsion balance method, $2.697 \pm 0.010 \text{ gcm}^{-3}$.—*D. B. V.*

- 170-178. Kazinskiy, V. A. Ob uravnoveshivaniy uprugoy sistemy gravitatsionnykh variometrov [On balancing the elastic system of gravitational variometers]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 4, p. 520-521, 1957.

A discussion of the correct procedure for balancing the elastic system of gravitational variometers.—*S. T. V.*

- 170-179. Popov, E. I. Opyt umen'sheniya razmerov kvartsevoy sistemy k gravimetram tipa Norgarda i CH3 [Experience in changing the dimensions of the quartz system of the Nørgaard type and CH3 gravimeters]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 670-672, 1957.

Experiments in 1953-1954 in reducing the overall dimensions of the CH3 gravimeter, the Russian variation of the known Nørgaard instrument, by using a smaller storage battery and smaller diameter quartz spring produced disappointing results as the dispersion of the readings was great, the drift of zero point was very high, and the operation of the gravimeters was rather unhandy. Production of the smaller size was discontinued.—*S. T. V.*

- 170-180. Caputo, Michele. On the behaviour of a Worden gravimeter for periodical variations in external temperature and rapid variations of pressure: Geophys. Prosp., v. 5, no. 2, p. 193-201, 1957.

Description of tests of the effect of large diurnal variations of temperature and rapid variations in external pressure on the Worden gravimeters used in the Italian Karakorum Expedition of 1954-55.—*M. C. R.*

- 170-181. Kilchling, Karl. Über eine Versuchsdrehwaage zur Messung des Horizontalgradienten des Vertikalgradienten der Schwere U_{zz} [On an experimental torsion balance for the measurement of the horizontal gradient of the vertical gravity gradient U_{zz}]: Gerlands Beitr. Geophysik, Band 66, Heft 2, p. 102-115, 1957.

An experimental torsion balance for measuring U_{zz} is described which very satisfactorily verifies the previously published theory of balances for measuring

the third derivatives of the gravity potential (see Geophys. Abs. 142-12134 and 142-12135).—*D. B. V.*

- 170-182. Thyssen-Bornemisza, Stephan [von]. Das zweistufige Gravimeter-Messverfahren. 2 Mitteilung [The two-stage gravimeter measurement method. 2d report]: *Erdöl u. Kohle*, Jahrg. 10, Heft. 6, p. 356, 1957.

Additional measurements of the vertical gradient of gravity in different parts of the United States and Cuba show that for the time being the two-stage gravimeter technique (see Geophys. Abs. 169-163) is still limited in its application to areas where deeper anomalies are not masked by surface disturbances due to variations in density and homogeneity of the ground. For purely geodetic problems, where other factors are determinative, the practical application might be possible sooner.—*D. B. V.*

- 170-183. Kneissl, Max. Die internationalen europäischen Gravimeter-Eichbasen [The international European gravimeter-measurement bases]: *Bayerische Akad. Wiss. Abh., math.-naturw. Kl.*, Heft 79, 53 p., 1956.

After more or less brief descriptions of the base stations and main pendulum points in the European gravimeter-measurement lines in Great Britain, France, Norway, Denmark, Germany, Italy, and Switzerland, the preliminary European fundamental gravity network is presented (as a comparison of the results of Coron, Hirvonen, Morelli, and Borrass); the details of the most important measurements up to 1954 are compiled, and results of those made between 1954 and June 1, 1956 are reported in somewhat greater detail.—*D. B. V.*

- 17-184. Morelli, Carlo, and Rice, Donald A., Gravimetric ties, Europe-America: *Bull. géod.*, no. 38, p. 35-41, 1955.

A Rome-New York gravimetric tie was made by the United States Coast and Geodetic Survey and the Osservatorio Geofisico di Trieste by repeated exchanges of four Worden gravimeters. The difference between Rocca di Papa and Idlewild No. 1 station is $6.16 \pm .02$ mgals. Rocca di Papa has been tied to the base station at Rome and the Idlewild station to the United States national base in Washington. Δg Rome-Washington is determined as -243.00 mgals.—*M. C. R.*

- 170-185. Caputo, Michele. Il collegamento gravimetrico Roma-Beirut-Karachi-Delhi-Dehra Dun effettuato dalla Spedizione Italiana al Karakorum 1954-1955 [The gravimetric tie Roma-Beirut-Karachi-Delhi-Dehra Dun made by the Italian expedition to Karakorum in 1954-55]: *Boll. Geodesia e Sci. aff.*, anno 16, no. 2, p. 139-166, 1957.

A summary of the procedure used in calibrating the Worden gravimeters used by the Expedition, and the computations and results of the Roma-Beirut-Karachi-Delhi-Dehra Dun tie. The Roma-Dehra Dun difference is -1285.2 mgal.—*M. C. R.*

- 170-186. Gilbert, R. L. G. Some comments on the results obtained with the Cambridge pendulum apparatus in North America: *Am. Geophys. Union Trans.*, v. 38, no. 4, p. 457-461, 1957.

Analysis of the results obtained by the Dominion Observatory with the Cambridge pendulum apparatus in 1952 and 1953 in establishing a gravity base line

from Mexico City to Fairbanks, shows that one of the five pendulums gave repeat readings within the order of accuracy expected, and that are in better agreement with those obtained with the Gulf apparatus, and hence is presumed to be more stable. The accuracy of pendulum observations has been based on the internal consistency of sets of swings but it might be more desirable to repeat several stations, if possible several times. In discussion following the paper G. D. Garland questions a method in which measurements made with four of five pendulums are neglected in favor of one.—*M. C. R.*

170-187. Kaula, William M. Deflections of the vertical in New Britain: *Am. Geophys. Union Trans.*, v. 38, no. 4, p. 578, 1957.

Nineteen astronomic observations made in connection with a control survey indicate unusually large deflections of the vertical throughout the length of New Britain; the pattern of deflections shows a marked correlation with topography.—*M. C. R.*

170-188. Worzel, J. Lamar and Shurbet, G. Lynn. Gravity observations at sea in USS *Corsair*: *Am. Geophys. Union Trans.*, v. 38, no. 3, p. 292-296, 1957.

In 1952, gravity observations at sea were made in USS *Corsair* (SS 435) with the Vening Meinesz pendulum apparatus at 31 positions from New London, Connecticut, to Nassau, Bahama Islands. The principal facts for these observations, including free-air and simple Bouguer anomalies, are presented in this paper. Isostatic corrections are being computed by the Mapping and Charting Research Laboratory, Ohio State University, under the direction of W. A. Heiskanen.—*Authors' abstract*

170-189. Saxov, Svend [E.]. Some gravity measurements in Thy, Mors, and Vendsyssel: *Denmark Geod. Inst. Skr.*, ser. 3, v. 25, 44 p., 1956.

A gravity survey was made in 1953-1955 of the area of Jutland north of Limfjorden. A detailed net of 1241 gravity stations was established in Thy, Mors, Vendsyssel, and Laeso from a base net of 9 stations; Aalborg and Holstebro were the base stations. Information for each detail station is given in tabular form. Gravity values are indicated as correct within 0.05 to 0.1 mgal and Bouguer anomalies within 0.1 mgal.

In Vendsyssel the predominant trend of the Bouguer anomalies is the large sheaf of curves in the area from Hals to Aalborg which continues in a north-westerly direction, gradually fanning out to leave the northwest coast between Blokhus and Hirtshals. This same sheaf of curves has been observed on Sjaelland, in southern Sweden, on Bornholm and can be traced into East Germany and Poland. The structure is a large fault or fault zone.

In Mors and Thy, an area of horsts and rifts, the correspondence between geologic structure and gravity is in general poor.

The region of Thy, Mors, and Salling has the greatest seismicity in Denmark. Of 42 Danish earthquakes, 22 have been felt only in northwestern or western Jutland and 12 of the 22 have been confined to Thy, Mors, and Salling. Comparison between the magnetic and gravimetric anomaly maps shows that, although two of the three major magnetic anomalies agree with geologic structure, in general gravity and geology agree better than do gravimetric and magnetic anomalies.—*V. S. N.*

- 170-190. Orgeval, M., and Zimmerman, M. Possibilités pétrolières de la zone subalpine, bassin méridional [Petroleum possibilities of the Subalpine zone, southern basin] : *Rev. Inst. Français du Pétrole*, v. 12, no. 5, p. 515-542, 1957.

Chapter 3 of this paper concerns the geophysical data on the basin bounded by the Central, Pelvoux, and Maures massifs in France. A gravity map compiled from several surveys shows clearly the major Nîmes-Pujaut fault, Hercynian in trend, separating the Cretaceous area with positive anomalies of 5-10 mgal from the Vistrenque depression with negative anomalies of -10 to -15 mgal. Borings show the throw along this fault to be well over 2,000 m. Its prolongation to the northeast separates the Tertiary Nyon-Valreas depression (-10 to -15 mgal anomalies) from the upper Cretaceous zone of Ventoux (+10 to +20 mgal). All the anticlines show up as positive anomalies. An aeromagnetic survey was attempted to supplement the gravity map; the results were not conclusive owing to the high flying altitude necessary (2,000 m) and low sensitivity of the instruments, but the large throw from the Nyon depression to Mount Ventoux was confirmed.—*D. B. V.*

- 170-191. Waterlot, Gérard. La position des sills de roches éruptives et des roches métamorphiques du massif cambrien de Rocroi comparée aux zones d'anomalies magnétiques positives et aux anomalies de Bouguer [The position of sills of igneous rocks and metamorphic rocks of the Cambrian Rocroi massif compared to the zones of positive magnetic anomalies and to the Bouguer anomalies] : *Soc. savantes Paris*, 80^e Cong., Comptes rendus, sec. sci., p. 103-108, 1955.

Geophysical surveys in the Cambrian massif of Rocroi in France, where surface geology is obscured by thick residual clays on the plateaus, completely corroborate deductions based on the geologic evidence. The 1953 gravity map (Bouguer) shows a zone of positive anomalies between Maubert-Fontaine and Remogne where a center of igneous intrusion had been inferred. Magnetic anomalies show three highs along anticlines in which igneous sills are interstratified; the strongest of these anomalies corresponds to the same probable intrusive center. The geophysical results not only clarify the distribution of the igneous rocks but explain the localization of regional metamorphism; the depth indicated for the magma (500-1,000 m) is in accord with the fact that the intrusive rocks occur essentially as sills.—*D. B. V.*

- 170-192. Nettleton, L. L. Gravity survey over a Gulf Coast continental shelf mound : *Geophysics*, v. 22, no. 3, p. 630-642, 1957.

A gravity survey of 50 stations over one of the mounds near the edge of the Continental Shelf developed a strong, roughly circular negative anomaly. The gravity minimum is similar in magnitude and lateral extent to those over large salt domes in the on-shore and explored offshore areas of the Gulf Coast. An approximate quantitative evaluation shows that the minimum can be accounted for quite completely by a large shallow salt dome. The shallow part of the dome is approximately coextensive with the topographic feature and it seems quite certain that this particular mound is genetically related to a salt dome. If other similar mounds also are salt domes, the area of domes off the Louisiana coast is approximately doubled over that presently known from commercial geophysical exploration.—*Author's abstract*

- 170-193. Tribalto, G[iuseppe], and Amadei, G[aetano]. Su alcuni risultati preliminari di misure gravimetriche nelle zone di Frosinone Cassino e Caserta (Italia centrale) [On some preliminary results of gravimetric measurements in the areas of Frosinone, Cassino, and Caserta (central Italy)]: Servizio geol. Italia Boll., v. 78, fasc. 3, p. 493-494, 1956.

A detailed gravity survey was made in the provinces of Frosinone and Caserta in central Italy. In an area of about 700 km², 850 stations were occupied. In the Frosinone area (from Roccasecca, San Giovanni Incarico, Pico and San Giorgio to Liri, Rocca d'Evandro, San Elia Fiumerapido and Cassino) a gravity low on the east is separated from a high on the west by a fault. The gravity high contains two maximums, one between Pico and San Giovanni Incarico, the other south of Pontecorvo. Results of the survey in Caserta have not yet been reduced.—*D. B. V.*

- 170-194. Maino, Armando, and Motta, Antonino. Nota preliminare sul rilevamento gravimetrico dell'area compresa nel Foglio 150 "Roma" [Preliminary note on the gravimetric survey of the area within the Folio 150, "Roma"]: Servizio geol. Italia Boll., v. 78, fasc. 3, p. 489-492, 1956.

The Bouguer map resulting from a gravimetric survey of the area of the Rome sheet of the geologic map of Italy shows a high between Tor Mastorta and Tor San Giovanni, corresponding to a closed anticlinal structure; a fracture zone east of Guidonia, probably the seat of hydrothermal and exhalative phenomena; a depressed area including the Settebagni, Settecamini, Ponte Lucano and Laghetto areas that probably determined the present lower course of the Aniene; another high in the Ciampino area (previously noted by Aquilina from pendulum measurements in the Colli Albani [Annali di Geofisica v. 1, no. 1, 1948]) probably corresponding to an igneous intrusion; a high between Pomezia and Castel Romano, probably due to the relief of the deep basement; and decreasing values in the extreme southeast part of the area, related to the pronounced low between Tribalto and Cisterna and Campoleone.—*D. B. V.*

Zaccara, Gaetano. Preliminary results on the water investigations made in the Roman Countryside in 1955. See *Geophys. Abs.* 170-112.

- 170-195. Katskov, A. I. Opyt primeneniya gravitatsionnogo gradientometra pri poiskakh kolchedannykh mestorozhdeniiy [Experiences with application of the gravitational gradiometer in prospecting for pyrite deposits]: *Razvedka i okhrana nedr*, no. 1, p. 41-48, 1957.

In 1955 a large-scale geophysical survey was made in several areas in the Karelian S. S. R. in search for pyrite deposits. Because the magnetic and the electrical methods used in previous geophysical surveys had not been successful, an attempt was made to use gravity differences as an indicator of the presence of pyrite. A special instrument—a gravitational gradiometer—was constructed for these measurements and tested in this survey.

The new instrument and the gravimeter were used together, so that U_{xx} and ∇U_{xx} , could be measured at the same time, the latter with an accuracy of ± 5 Eötvös units. The new instrument is said to be much more effective than a torsion balance. Construction details and characteristic curves are not given. Data were interpreted by the method of B. A. Andreyev; good agreement was found between the interpreted and the drilling results.—*S. T. V.*

- 170-196. Plassard, Jacques. État de la gravimétrie au Liban en fin de 1953 [State of gravimetry in Lebanon at the end of 1953]: Observatoire Ksara (Lebanon) Annales, Mém., tome 2, cahier 1, 42 p., 1953.

New gravimeter measurements were made in Lebanon in 1952 and 1953 using a Western instrument. Thirty-seven stations were occupied for which free air and Bouguer anomalies have been calculated. These anomalies were also recalculated for several older gravity measurements in Turkey, Syria, Lebanon, and Palestine. The results are presented in detail, including tables, maps (Bouguer and free air anomalies for Syria and Lebanon on a scale of 1:4,000,000; Bouguer and free air anomalies for central and southern Lebanon on a scale of 1:500,000); free air and Bouguer profiles from Beyrouth to Damascus; and detailed descriptions of each of the new stations.—*D. B. V.*

- 170-197. McCulloh, Thane H. Simple Bouguer gravity and generalized geologic map of the northwestern part of the Los Angeles Basin, California: U. S. Geol. Survey Geophys. Inv. Map GP 149, 1957.

A gravity survey that included 1,267 observations at 857 stations was made in the northwestern third of the Los Angeles Tertiary basin. Almost every known major structural feature in the area is reflected by a gravity anomaly; many of the smaller structures also produce anomalies. In addition several anomalies of the north flank of the basin are not directly related to known geologic structures, and each holds some promise of economic value.—*M. C. R.*

- 170-198. Smith, Raymond J. Gravity cross-section of the coast range of Venezuela: Am. Geophys. Union Trans., v. 38, no. 3, p. 372-378, 1957.

In a reconnaissance gravity survey in 1949, 44 stations were established across the Cordillera de la Costa from La Guaira to Ortiz. Modified Bouguer anomalies show a +45 mgal zone north of Caracas, an east-west zone negative zone (−40 mgal) between Caracas and San Juan de los Morros, and a −15 mgal zone to the south. This pattern could be produced by a combination of normal thickening of the metasedimentary sequence, the presence of the thin edge of the gigantic crust, and a slight regional downwarp not yet isostatically adjusted.—*M. C. R.*

HEAT AND HEAT FLOW

- 170-199. Lyubimova, Ye. A. O roli luchistogo teploobmena v teplovom regime zemli [On the effect of the heat exchange by radiation in the thermal regime of the earth]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 673-676, 1957.

Experimental determination of the coefficient of heat conduction λ , at different temperatures, of MgO, Al₂O₃, BeO, which are present in great amounts in the upper layer of the crust, showed that λ decreases with increase of temperature at temperatures up to 1,500-1,800° C, but rapidly increases at higher temperatures. This relation can be explained by assuming that $\lambda = \lambda_1 + \lambda_2$, where λ_1 is the usual coefficient of heat conduction, but λ_2 is the heat dissipated by the radiation between the molecules. Formulas for λ_1 and λ_2 involving density of the substance, average velocity of sound, absolute temperature, coefficient of refraction, Stefan-Boltzman constant, and the coefficient of absorption, are given. By using values of these constants from most recent studies in the formulas, a rather complicated expression for the temperature at any depth of the earth is obtained. Results indicate that at about 100 km the crust has a temperature much lower than

previously computed, so that loss of heat into interstellar space is substantially smaller. At the depth of about 2,000 km the heat conductivity is 3 to 4 times higher than previously thought, and the temperature of the earth's interior still continues to rise.—*S. T. V.*

- 170-200. Goguel, Jean. Influence des variations de la température superficielle sur le degré géothermique, en particulier dans le cas d'un sol gelé permanent [Influence of surface temperature variations on the geothermal gradient, especially in permafrost]: *Annales Géophysique*, tome 12, no. 3, p. 183-201, 1956.

In order to interpret the very high thermal gradient recently obtained in permafrost at Resolute Bay (values about 2.5 times greater than normal), Goguel calculates the effect of permafrost on the propagation in depth of variations of surface temperatures and shows that the gradient is exaggerated by its existence. In the calculation a porosity of 0.1 and a lowering of temperature of 10° 1,000 to 2,000 years ago is assumed and displacement of the base of the permafrost is taken into account. The calculation is only theoretical and cannot explain whether the gradient at Resolute Bay is due to an exceptionally high value of the geothermal flux or whether it is due to variations in surface temperatures in the recent past, or both; it shows only what the order of magnitude of surface temperature variations should be to account for the observations. Goguel suggests that the variations of temperature during the late Quaternary could have had a greater influence on the gradients than is commonly admitted, and that the exact value of the geothermal flux cannot be determined without due allowance for these variations.—*B. T. E.*

- 170-201. Studd, F. E. Wairakei hydrothermal system and the influence of ground water: *New Zealand Jour. Sci. Technology*, sec. B, v. 38, no. 6, 595-622, 1957.

This paper is concerned mainly with the dynamics and exploitation of the thermal waters and steam at Wairakei, New Zealand, irrespective of origin, and with the influence of the cold meteoric waters that form part of its environment in the permeable pumice breccias. Maximum heat flow is naturally provided for by the prevalent conditions: ground water everywhere at boiling point but free from steam. Temperatures above the boiling-point curve indicate a pocket of dry steam, below it, the influx of cold water. A dynamic balance exists between cold-water influx and boiling, and heat flow in the hydrothermal system as a whole depends upon this balance. Shortage of ground water impedes heat flow by allowing the blocking action of steam; abundance of ground water aids it by keeping temperatures around the boiling point; but superabundance of ground water reduces heat flow by cooling below the boiling point. This hypothesis is supported by the definite correlation between heat flow and rainfall at Wairakei and by the fact that dissimilar hydrologic conditions give rise to dissimilar heat flow in Geyser Valley and Waiora Valley. A discrepancy between estimates of natural heat flow based on chemical and physical evidence (82,000 and 138,000 kcal per sec, respectively) is probably due in part to a real decrease in natural heat flow, for the physical measurements were made 3 years before the chemical, during which there must have been a rise in heat loss through the steam bores. The reduction in impedance offered by drill holes increases heat flow; by mid-1956 total heat flow in the Wairakei drill holes had doubled, while natural heat flow, although declining, was not yet very greatly diminished. Estimates of the

ultimate capacity of the field will have to be based on close study of trends in natural heat flow and performance of individual drill holes. Within the depths so far penetrated, there is no indication of high pressure steam channels of the Larderello type; there is no indication of anything more than a body of water close to boiling with purely local accumulations of steam.—*D. B. V.*

- 170-202. Contini, Camillo. La prospezione termometrica del vapore naturale [Thermometric prospecting for natural steam]: *Geofisica e Meteorologia*, v. 4, no. 4/5, p. 61-95, 1956.

A new method of prospecting for deposits of natural steam, analogous to other geophysical methods such as magnetic or gravimetric, is based on anomalies of the geothermal gradient. The theoretical anomalies resulting from the following cases are illustrated: a point source near the surface in homogeneous isotropic ground (with plane surface and with irregular surface): two equal point sources in an infinite homogeneous isotropic medium; an infinite, horizontal, linear source near the surface in homogeneous isotropic ground (with plane surface and with irregular surface); and a semi-infinite vertical linear source in homogeneous isotropic ground. In practice, temperature measurements are made at regular intervals in each of a series of boreholes, such as those commonly used in seismic work (mostly about 50 m deep for purposes of economy, but with a suitable proportion of deeper holes to avoid error due to surface influences—for example, about $\frac{1}{4}$ of the total number are 100 m deep and about $\frac{1}{25}$ are 200 m or more). The measurements must be corrected for topographic, free-air, and regional effects (graphs to facilitate the first are presented). Interpretation of the corrected results is explained. The use of maximum mercury and electrical resistance thermometers is discussed. Organization and costs of such a survey are treated in the final section of the paper.—*D. B. V.*

INTERNAL CONSTITUTION

- 170-203. Bullen, K. E., and Burke-Gaffney, T. N. Evidence relating to the earth's inner core from hydrogen bomb explosions in 1954: *Nature*, v. 180, no. 4575, p. 49-50, 1957.

Stations in the distance range of 137° to 142° recorded wave movements from the bombs as much as 12 seconds before the expected arrival times as well as larger phases that agreed within 2 seconds with the expected arrival times of *PKIKP*. The early waves correspond to diffracted waves and supplement proof that *PKIKP* is not a diffracted wave but one due to the inner core.—*M. C. R.*

- 170-204. Nakamura, Kōhei. On the viscoelastic nature of the earth's core: *Tōhoku Univ. Sci. Repts.*, 5th ser., v. 8, no. 1, p. 93-110, 1956.

It is assumed that the earth's core is composed of a homogeneous viscoelastic material and that its departure from perfect elasticity arise under distortional stress and can be expressed by a certain stress-strain relation of Maxwell's type. For motion of period of several seconds, such as seismic waves in the core, such a material behaves as perfectly elastic in the range $\tau > 10^1$ sec and as a fluid in the range $\tau < 10^{-1}$ sec, where τ is the relaxation time due to Maxwell flow. From seismological considerations, the large amplitude of *ScS* at short epicentral distances, small absorption of *P*, and heavy damping of *S*, permissible upper limits of

the "instantaneous mean rigidity" and mean viscosity can be determined as functions of τ . In an "elastic fluid" core characterized by large values of τ , the maximum value of the mean rigidity is 10^9 cgs and mean viscosity 10^{18} cgs; for τ smaller than 10^{-1} cgs (viscous fluid), the maximum mean rigidity is 10^{12} cgs and mean viscosity 2×10^9 cgs. The elastic fluid type core is considered more likely to exist.—*M. C. R.*

170-205. Haalck, Hans. Zur Frage der inneren Gliederung des Gesteinsmantels der Erde [On the question of the internal partitioning of the earth's rock mantle]: *Forschungen u. Fortschr.*, 31 Jahrg., Heft 6, p. 168-175, 1957.

A review of knowledge of the constitution of the mantle gained from seismological observations, summed up as follows: peridotite layer of outer mantle, from the Mohorovičić discontinuity at 30 to 40 km to about 350 km; transition zone, 350 km to 600 or 700 km; inner mantle, 600-700 to 2600-2700 km; transition zone 2600-2700 to 2900 km; core, below 2900 km. Changes in composition rather than phase changes are predominantly responsible for the layering. The transition zone between inner and outer mantle is of greatest interest, for the deeper earthquakes show that this layer is not uniform horizontally; sharp differences exist in temperature, elastic properties, probably also of density (but to a lesser degree), and of phase. These differences lead to the possibility of convection currents, and electromotive forces varying with time. It is suggested that it is in this zone, not in the core, that the main causes of mountain building and magnetic secular variations should be sought.—*D. B. V.*

170-206. Holser, W. T., and Schneer, C. J. Polymorphism in the earth's mantle: *Am. Geophys. Union Trans.*, v. 38, no. 4, p. 569-577, 1957.

Polymorphism has been proposed to explain seismic discontinuities without chemical change. Topological and thermodynamic classifications of polymorphism indicate a much wider range of possible types than previously described, with the further possibility of seismic discontinuities independent of density changes. Polymorphic transformations are topologically classified as: (1) open packing to cp (close-packed), (2) rearrangement of interstitial atoms in cp structures, (3) coordination change, (4) electronic transformation, and (5) rearrangement of cp atoms. Calculation of repulsion energy for coordination change indicates an increase of cation coordination number with high pressure, but the effect of temperature cannot be generalized.

Transformations of types (1), (3), and (4) are first order, with a volume change, latent heat, and change of elastic constants. Types (2) and (5) are second order in an ideal case, with an abrupt change of elastic constants at a critical point, but with volume and heat changes spread over a wide range.

With increasing depth, a single composition might undergo a series of transformations with consequent effect on the seismic observations: a low-pressure open structure collapses to cp; the cations move from tetrahedral to octahedral holes, then into high coordination positions where they are an essential part of the packing; and ions release their electrons to the conducting state (starting with the oxygen ion). While interstitial atoms are still present, they may rearrange in response to temperature or pressure changes. At some undetermined stage cp atoms may rearrange, as from cubic cp to hexagonal cp.—*Authors' abstract*

- 170-207. Lyustikh, Ye. N. O konveksii v obolochke zemli po raschetam Pekerisa [On convection in the earth's mantle in accordance with the computations of Pekeris]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 604-615, 1957.

Lyustikh considers that the crustal convection currents suggested by Pekeris are possible, but that the physical theories, on which his computations are based, are erroneous. Certain kinds of convection currents, if started, would eventually be destroyed. Some scheme of convection may have existed during the geologic history of the earth, but such convection stopped long ago. Analysis of the world's gravity map and regions of isostatic anomalies indicates that these anomalies cannot as well be the cause of continuous convective movement. The value of the coefficient of the kinematic viscosity of the earth's mass as determined from the upheaval of Fennoscandia is believed wrong; if, for instance, the upheaval of the Moscow syncline is taken instead, the value of the viscosity is 10,000 times greater.—S. T. V.

- 170-208. McDonald, Keith L[eon]. Penetration of the geomagnetic secular field through a mantle with variable conductivity: Jour. Geophys. Research, v. 62, no. 1, p. 117-141, 1957.

The radial distribution of electrical conductivity, σ , to the 800-km depth has been inferred by earlier investigations from geomagnetic transient variations of external origin. In this investigation the longer wave periods of the geomagnetic secular variation are used to study σ in the lower parts of the mantle. A power law is assumed for conductivity in the quasistationary field equations for the mantle. Solutions are obtained in terms of Bessel functions. Plots of amplitude attenuation and phase retardation after propagation through the mantle indicate that lower order harmonics are physically attenuated more than higher order and that there is a space dispersive effect that distorts surface wave shapes.

An equivalent conductivity based on amplitude attenuation is established to facilitate the transfer from a homogeneous medium to one of variable conductivity. The electrical conductivity is estimated by the replacement of the time average of the space-averaged squared field at the core by a random static distribution. This quantity as attenuated by the mantle is compared with its observed image at the earth's surface. The results of this study are combined with results of others to obtain a plot of electrical conductivity distribution in the mantle.—R. G. H.

- 170-209. Dohr, Gerhard. Zur reflexionsseismischen Erfassung sehr tiefer Unstetigkeitsflächen [On the detection by seismic reflection of very deep surfaces of discontinuity]: Erdöl u. Kohle, Jahrg. 10, Heft 5, p. 278-281, 1957.

The strong reflections apparently from great depths obtained in the course of seismic reflection surveys in the vicinity of Rastatt to Achern, Baden-Oos, Bühl, and Murnau in Germany may be real reflections from discontinuities in the crust, not multiple reflections. In the Murnau area, the depths to all three surfaces are calculated from reflections appearing at 4.5, 6.5, and 11 sec to be 10.5-11.0, 17.0-18.0, and 30.0-31.0 km deep, respectively. These depths are in good agreement with crustal structure deduced for the region from near earthquake and explosion data. The discontinuity at 17-18 km seems to dip generally southward and is deeper than expected in the Rastatt-Achern and Murnau areas; the Rhine graben may involve this discontinuity.—D. B. V.

- 170-210. Raitt, Russell W. Seismic refraction studies of Eniwetok atoll : U. S. Geol. Survey Prof. Paper 260-S, p. 685-698, 1957.

Observed seismic velocities at Eniwetok Atoll indicate the presence of 6 layers of rock, in which the average velocities are 2.44, 3.06, 4.15, 5.59, 6.90, and 8.09 km/s, respectively. Previous drilling permits the identification of the first 2 layers as calcareous deposits and the third layer (4.15 km/s) as volcanic. The calculated depth of the third layer beneath the drilling sites was about 0.3 km greater than the depths at which volcanic rock was penetrated by the drill. This may be due to the fact that, in calculations, the vertical seismic velocities in the first 2 layers were assumed to be equal to the horizontal velocities measured in those layers, whereas the vertical velocities are probably less because of the presence of unconsolidated material between the cemented layers in the first 2 zones.

The fourth layer (5.59 km/s) is thought to be a hard crystalline rock, probably basalt. The fifth layer (6.90 km/s), identified with the crustal layer extensively present in the Pacific Ocean basin, is found at a depth of 9-10 km, and the sixth layer (8.09 km/s), characteristic of the layer just below the Mohorovičić discontinuity, is reached at a depth of 16-17 km.—*Author's abstract*

- 170-211. Doyle, H. A. Seismic recordings of atomic explosions in Australia : *Nature*, v. 180, no. 4577, p. 132-134, 1957.

Explosions of atomic weapons at Maralinga, South Australia, in October 1956 were recorded at roughly 2° interval to a distance of 10.7°. P_n , P_1 , S_n and S_1 were identified; the velocities were 8.23, 6.12, 4.75, and 3.56 km/s. P_n and S_n traveltimes were 6 and 14 seconds earlier than those given in the Jeffreys-Bullen tables for 10°. The thickness of the crust was calculated as 35 km from P -wave data, 40 km from S -wave data.—*M. C. R.*

- 170-212. Ewing, J. I., Officer, C. B., Johnson, H. R., and Edwards, R. S. Geophysical investigations in the eastern Caribbean: Trinidad Shelf, Tobago Trough, Barbados Ridge, Atlantic Ocean: *Geol. Soc. America Bull.*, v. 68, no. 7, p. 897-912, 1957.

A number of seismic refraction stations were occupied in the eastern Caribbean area, and the results are correlated with other geophysical measurements and with land geology. The purpose of the investigation was to measure the crustal and subcrustal structure in the Caribbean, along the island arc, and in the Atlantic to determine the structural relationship of the interior-basin-island-arc-deep sea sequence. The measurements indicate that the Caribbean was formerly an oceanic area which is a large part has been altered to produce a thickened crust and a lowered seismic velocity in the subcrustal material. Along the island arc the crust has been considerably thickened, and its upper surface approximately parallels the topography. On the Atlantic side of the islands the crustal and subcrustal layers are downwarped or downthrust to parallel approximately the topography across the Puerto Rico trench and its extension.—*Authors' abstract*

- Lyubimova, Ye. A. On the effect of the heat exchange by radiation in the thermal regime of the earth. See *Geophys. Abs.* 170-199.

- 170-213. Hill, M. N. Geophysical investigations on the floor of the Atlantic Ocean in *Discovery II*, 1956: Nature, v. 180, no. 4575, p. 10-13, 1957.

A report of a discussion meeting at the Royal Society on May 2. M. N. Hill described the bottom topography in the eastern Atlantic: a shallow smooth area west of Scotland; abyssal plains close to the foot of the continental shelf; a more shallow, greatly sloping area with sea mounts and ridges west of the abyssal plains; and the Mid-Atlantic Ridge. R. D. Adams reported that studies of the dispersion of surface waves from shocks in the northern part of the Mid-Atlantic Ridge show the structure is typically oceanic. M. N. Hill reviewed seismic refraction measurements in the Atlantic and Pacific; most recent work confirms the idea that the eastern Atlantic is similar to the western Atlantic and the Pacific. Hill and E. C. Bullard discussed the total-intensity magnetic measurements made with a nuclear spin magnetometer and a fluxgate magnetometer. Magnetic anomalies suggest that the Hercynian folding in Brittany extended out to sea. The continental shelf and slope are magnetically smooth, but in deep water anomalies of 2 km wavelength, in some places associated with topography, are superposed on anomalies of 12 km wavelength. Other speakers described bottom photography, deep water current measurements, bottom samples, and work on cosmic spherules.—*M. C. R.*

ISOSTASY

- 170-214. Lyustikh, E. N. Izostasiya i izostaticheskkiye gipotezy [Isostasy and isostatic hypotheses]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 38 (165), p. 1-90, 1957.

This is a discussion on isostatic hypothesis in its various forms (Airy, Pratt, Vening Meinesz, Hayford). It is concluded that isostatic equilibrium is the approximate condition of the crust but that large areas are either under-compensated or over-compensated; thus the isostatic hypothesis requires the assumption of a force tending to restore isostatic equilibrium. But still great areas of the earth's surface remain in the state of isostatic disequilibrium.—*S. T. V.*

- 170-215. Lagrula, Jean. Imperfection de l'équilibre isostatique au Sahara [Imperfection of isostatic equilibrium in the Sahara]: Acad. Sci. Paris Comptes Rendus, tome 244, no. 24, p. 2951-2952, 1957.

The isostatic anomalies in the Sahara region are related systematically to surface formations, being positive where these are dense, and negative where they are light. There are very large areas (on the order of 500,000 km²) where isostatic anomalies keep the same sign. The slicing effort to which the crust is subjected along the lines bounding zones of positive and negative isostatic anomalies is estimated to be at least 10⁸ tons per meter; but the effect of tectonic movements tending to reestablish equilibrium should be taken into account. The isostatic anomalies correspond more closely to structure than the Bouguer, and paradoxical as it may seem at first, correspondence should increase as degree of compensation increases: in effect, in the center of a vast homogeneous area isostatic anomalies should be zero, but in fact they are not and depend on the density of surface layers. This circumstance can be expressed by the approximate formula: the geologic correction should not allow for compensation.—*D. B. V.*

- 170-216. Crenn, Y[onna]. Limites des possibilités de compensation isostatique locale sur le socle stable de l'A. O. F. [Limits of the possibilities of local isostatic compensation on the French West African stable basement]: *Annales Géophysique*, tome 12, no. 3, p. 209-224, 1956.

In the central part of French West Africa the mean value isostatic anomaly is only about 2.1 mgals, regardless of the compensation correction method used. In the Bandiagara region a plateau 80 km wide and 150 m higher than the surrounding area produces only regional anomalies independent of altitude indicating that the crust in this area can support about 8×10^6 tons per meter without compensation. There seems to be local compensation whenever fractures through the crust make it possible, as the result of a heavy mass (probably greater than 3×10^6) or tectonic forces that add to the weight of gravity. In other places the compensation is regional, and the crust is sinking elastically, according to the theory of Vening Meinesz. In regions which are at present tectonically stable an ancient geosyncline may produce a negative anomaly of considerable extent.—*B. T. E.*

ISOTOPE GEOLOGY

- 170-217. Polański, A[ntoni]. Critical remarks on some geochemical speculations concerning atmospheric argon: *Acad. Polonaise Sci. Bull.*, 3^e cl., v. 5, no. 5, p. 545-550, 1957.

Computed results of the total amount of radiogenic argon-40 in the earth depend on the value assumed for the age of the earth, the amount of potassium-40 in different parts of the earth, and the branching ratio, and in the present state of knowledge of these quantities, no real values of the total amount, or what part of the total corresponds to the argon-40 in the atmosphere, or the rate of escape of argon-40 from the interior can be estimated. There is no way of determining whether the existing atmospheric argon was produced entirely from potassium in the crust or if potassium in the mantle contributed to its formation. Sufficiently reliable calculations of the age of atmospheric argon cannot be made, even if it is assumed that all atmospheric argon-40 is derived from potassium in the crust because of lack of knowledge of necessary data. Any computations based on the amount of radiogenic argon-40 in the atmosphere, such as Kulp's proof of the internal origin of the hydrosphere, Rankama's determination of the amount of weathered igneous rocks, and the age of the earth as determined by Shillibeer and Russell, must be viewed with caution.—*M. C. R.*

- 170-218. Craig, Harmon. The natural distribution of radiocarbon and the exchange time of carbon dioxide between atmosphere and sea: *Tellus*, v. 9, no. 1, p. 1-17, 1957.

Steady-state equations governing the transfer and distribution of a radioactive isotope between its various exchange reservoirs are applied to the natural distribution of carbon-14. The radiocarbon enrichment or depletion in each reservoir, relative to the hypothetical state in which mixing is infinitely faster than the decay rate, is evaluated as a quantitative function of the exchange rates between the reservoirs. From the observed distribution of C^{12} , C^{13} , and C^{14} in the atmosphere, biosphere, and sea, and from the estimated production rate of C^{14} by cosmic rays, the residence time of a carbon dioxide molecule in the atmosphere, before entering the sea, is found to be between four and ten years.

The atmospheric residence time may also be evaluated, independently of the estimated C^{14} production rate, by considering the functional dependence of the C^{14} concentration in the oceanic mixed layer on the residence times in the atmosphere and the deep sea. This second method of evaluation also leads to an atmospheric residence time of about seven years. The average annual exchange flux of carbon dioxide into the sea is thus about 2×10^{-3} moles per square centimeter of sea surface. The average residence time of carbon dioxide in the deep sea is estimated as probably not more than about 500 years.—*Author's abstract*

170-219. Revelle, Roger, and Suess, Hans E. Carbon dioxide exchange between atmosphere and ocean and the question of an increase of atmospheric CO_2 during the past decades: *Tellus*, v. 9, no. 1, p. 18-27, 1957.

From a comparison of C^{14}/C^{12} and C^{13}/C^{12} ratios in wood and in marine material and from a slight decrease of the C^{14} concentration in terrestrial plants over the past 50 years it can be concluded that the average lifetime of a CO_2 molecule in the atmosphere before it is dissolved into the sea is of the order of 10 years. This means that most of the CO_2 released by artificial fuel combustion since the beginning of the industrial revolution must have been absorbed by the oceans. The increase of atmospheric CO_2 from this cause is at present small but may become significant during future decades if industrial fuel combustion continues to rise exponentially.

Present data on the total amount of CO_2 in the atmosphere, on the rates and mechanisms of exchange, and on possible fluctuations in terrestrial and marine organic carbon, are inadequate for accurate measurement of future changes in atmospheric CO_2 . An opportunity exists during the International Geophysical Year to obtain much of the necessary information.—*Authors' abstract*

170-220. Arnold, James R., and Anderson, Ernest C. The distribution of carbon-14 in nature: *Tellus*, v. 9, no. 1, p. 28-32, 1957.

The carbon-14 activity of oceanic materials indicates that the mixing half-time for carbon between the atmosphere and ocean surface waters is one or two decades, while the turnover time for the ocean as a whole is several hundred years. This conclusion is consistent with estimates based on the measured decrease in carbon-14 specific activity of wood grown in recent years compared with 19th-century wood.—*Authors' abstract*

Patterson, R. L., Jr., and Blifford, I. H., Jr. Atmospheric carbon-14. See *Geophys. Abs.* 170-6.

de Vries, Hl. Contribution of radiocarbon dating and measurement of paleotemperatures to Pleistocene correlations. See *Geophys. Abs.* 170-7.

170-221. Landegren, Sture. Preliminary note on the isotopic composition of carbon in some Swedish rocks: *Geol. Fören. Stockholm Förh.*, band 79, häfte 2, p. 274-275, 1957.

Presents the results of determinations of the C^{12}/C^{13} ratio in graphite and carbonate in four samples of black graphite schist from the lower Grythytte series in central Sweden, and of graphite in Precambrian gneiss from five places in Sweden. The graphite in the gneiss is found to be mainly of organic origin, like that in the schists, suggesting that the former were originally sedimentary, regionally metamorphosed to gneiss.—*D. B. V.*

- 170-222. Nicolet, Marcel. The aeronomic problem of helium: *Annales G ophysique*, tome 13, no. 1, p. 1-21, 1957.

The escape of helium from the terrestrial atmosphere has been investigated, taking account of the simultaneous presence of helium-4 and its isotope helium-3 in the atmosphere.

The generation mechanisms for helium-4 and helium-3 are, respectively, the radioactivity of the earth's crust ($\leq 1.7 \times 10^6$ He⁴ atoms cm⁻² sec⁻¹) and the presence of cosmic radiation (≤ 2 He³ atoms cm⁻² sec⁻¹) and lead to a unique escape time of the order of 2 millions of years. If the temperature of the thermopause (2,500° K to 3,000° K) is such that there is an escape of He⁴, this causes the complete escape of He³ from the thermospheric region in which diffusion takes place.

The process limiting escape is associated with the action of mixing in the region below the thermosphere. Under these conditions the atomic flow is proportional to the respective concentrations of He⁴ and He³. Thus, the ratio ($\sim 10^6$) of the rates of escape of He⁴ and He³ equals the ratio of the production rates, and is consequently equal to the ratio of the concentration observed in the troposphere. From this it is concluded that the temperature of the thermopause must be variable and very high during short periods of time associated directly or indirectly with the solar activity.—*Author's abstract*

- 170-223. Cziki, K., and Fodor, J. Study of the deuterium content of natural inland waters and vegetable saps: *Acta Geol. Acad. Sci. Hungaricae*, tomus 4, fasc. 2, p. 131-142, 1956.

Experimental determinations indicate rain and snow contain less deuterium oxide than standard tap water in Budapest. The densities of waters from the Danube, springs in Budapest, the mine at Koml , stalactite cave at Aggtelek, and Lake Balaton were not different from that of tap water. Decreased density in the water of the thermal spring at H v z may be explained by the post-volcanic origin of the spring. Increased density in the waters of deep borings in the Great Hungarian Plain may indicate the water originates from primeval sea water. Waters from carbonic acid springs near Lake Balaton were slightly more dense than the reference, and a sample of water from the Black Sea showed an increased density. Figures are also given for saps of vegetable cellules.—*M. C. R.*

- 170-224. Shaw, Denis M. Comments on the geochemical implications of lead-isotope dating of galena deposits: *Econ. Geology*, v. 52, no. 5, p. 570-573, 1957.

It has been suggested (see *Geophys. Abs.* 165-313 and 166-26) that because of inhomogeneity of the crust the source of most lead deposits lies in the mantle rather than in the crust. The evidence for these conclusions is insufficient and it is not necessary to postulate a subcrustal source for galena deposits. The crust is heterogeneous but crustal processes, especially gradation, diastrophism, and vulcanism tend to restore homogeneity. Present crustal abundance of lead is 15 ppm, and has increased by 5 ppm since the beginning of geologic time. Crustal abundances of uranium and thorium are estimated at present to be 2.4 and 10 ppm, respectively and original abundances to be 4.8 and 12.5, respectively by using Patterson's age of the earth of 4.55×10^9 (see *Geophys. Abs.* 167-5). The decreases during geologic time of 2.4 and 2.5 ppm are the

increase in abundance of Pb-206 and Pb-208, the total, 4.9 ppm, shows close agreement with the increase obtained by the lead abundance alone. This result tends to confirm the confidence attached to the abundance figures and the hypothesis of crustal origin of lead ores. The abundance figures all relate to igneous rocks but as many igneous rocks are formed by regenerative processes the argument is not nullified. The solution of the problem of anomalous galenas must await further information.—V. S. N.

MAGNETIC FIELD OF THE EARTH

- 170-225. Elsasser, Walter M. Hydromagnetic dynamo theory: *Rev. Modern Physics*, v. 28, no. 2, p. 135-163, 1956.

By neglecting the displacement current in Maxwell's equations and certain higher order terms, a combination of the electromagnetic field equations with the Euler (or Stokes) equations of fluid motion with suitable coupling terms between motion and field (the hydromagnetic equations) is obtained. These equations are used to study the mechanism by which the magnetic fields of the earth of sunspots and the sun, and of magnetic stars are generated and maintained. A system that can maintain magnetic fields swing to motions in electrically conducting fluids is a hydromagnetic dynamo. The existence of such dynamos that are stationary in the mean is considered here; the role of the Coriolis forces is emphasized. A detailed discussion is given of motion in the core and their effect on the geomagnetic field. Reversals of the field may take place in a few thousand years, and consists of a vanishing of the dipole field which continues into the appearance of a field of opposite polarity rather than a migration of the dipole axis.—M. C. R.

- 170-226. Mauersberger, P. Über die Berücksichtigung der Erdabplattung bei der Potentialentwicklung des geomagnetischen Hauptfelds [Consideration of the oblateness of the earth in the potential development of the main geomagnetic field]: *Gerlands Beitr. Geophysik.*, Band 66, Heft 1, p. 34-45, 1957.

It is shown that, if the oblateness of the earth is taken into account, and if "Neumann's" method is used in deriving them, the Gauss coefficients of the main magnetic field alter in proportion to the ellipticity and probably by about 1γ to 10γ . Whilst today it is of theoretical interest to consider the influence of the earth's oblate form on the spherical harmonic analysis, and whilst in future it will get practical importance too, today it is not necessary to take it into account.—*Author's abstract*

- 170-227. Mauersberger, P. Berechnung der Höhenabhängigkeit geomagnetischer Normalfelder [Calculation of the effect of altitude on the main geomagnetic field]: *Gerlands Beitr. Geophysik*, Band 66, Heft 1, p. 46-57, 1957.

Supposing the existence of a potential only by simple computation and without further measurement, the usual normal values of all "elements" of the earth's main magnetic field are "completed" to Taylor-series in the differences of the geographical latitude and longitude and the height above sea level between any point and the "reference point." The possibility of some practical use of such a "generalized" normal value is discussed, and the Magnetische Reichsvermessung 1935.0 of Germany is "completed" in the sense mentioned above.—*Author's abstract*

- 170-228. Beiser, Arthur. Variations in the geomagnetic dipole in the past 15,000 years: Jour. Geophys. Research, v. 62, no. 2, p. 235-239, 1957.

It is shown that the most likely cause of discrepancies between the ages t of archeological specimens determined from radiocarbon measurements and the corresponding actual ages t^1 is a long-period variation in the magnetic dipole moment M of the earth. The relationship $\Delta M/M \approx 2\{\exp[-1.24 \times 10^{-4}(t^1 - t)] - 1\}$ is obtained. Comparison with the limited data available shows that, between roughly 5,000 and 15,000 years ago, any changes in M that persisted for times of the order of several thousand years could not have exceeded about 10 percent of the mean value of M in that interval. Shorter-period fluctuations could have been greater, particularly if oscillatory variations occurred. The approximate agreement between the current rate of production of radiocarbon and the mean rate necessary to account for the existing radiocarbon inventory extends this conclusion down to the present day, excluding the possibility that any major, long-term changes in the magnitude of the earth's magnetic field took place in the past $\sim 15,000$ years.—*Author's abstract*

- 170-229. Hope E. R. Westward drift and cyclic secular variation: Jour. Geophys. Research, v. 62, no. 2, p. 241-253, 1957.

A westward rotation of magnetic features is observed which has a periodicity of approximately 1,400 years and is in general agreement with harmonic analyses of the surface geomagnetic field. A higher frequency drift, about 450 years, however, is observed for the secular variation of rotation of the north-seeking end of the magnetic needle. Observations at London from 1540 to 1950 indicate that this clockwise rotation will be completed in another half century. Harmonic analysis of the surface geomagnetic field also results in a second-order periodicity of 454 to 528 years.

A comparison of these phenomena with the magnetic field of the sun as indicated by solar corona indicates relative movement between an outer shell and an inner core. Part of the magnetic field may be a result of activity of the core surface and part of activity at different depths within the core. Thus magnetic zones of differing periodicity may result as a consequence of differing angular velocities within the core.—*W. J. D.*

- 170-230. Zmuda, A. J. Extrapolation of geomagnetic field components along a radius from the center of the earth: Am. Geophys. Union Trans., v. 38, no. 3, p. 306-307, 1957.

An approximate method of extrapolating geomagnetic field components is presented in which a very small amount of data is required to effect the continuation. From intensity values at two points lying on a common radius from the center of the Earth, an attenuation factor is obtained which is used in an exponential formula to extrapolate to additional collinear points.—*Author's abstract*

McDonald, Keith Leon. Penetration of the geomagnetic secular field through a mantle with variable conductivity. See Geophys. Abs. 170-208.

- 170-231. Kato, Yoshio, and Watanabe, Tomiya. A survey of observational knowledge of the geomagnetic pulsation: Tōhoku Univ. Sci. Repts., 5th ser., v. 8, no. 3, p. 157-185, 1957.

A review. Bibliography of 112 items arranged chronologically.—*M. C. R.*

- 170-232. Alexander, N. S., and Onwumechilli, C. A. Variation of the horizontal force near the magnetic equator: *Nature*, v. 180, no. 4578, p. 191-192, 1957.

The ratio of the range of the variation of the horizontal component of the geomagnetic field recorded at nine field stations between lat $6^{\circ}36'N$ and $13^{\circ}N$ (about 3° north and 3° south of the magnetic equator) to that at the observatory at Ibadan (lat $7^{\circ}26'N$, long $3^{\circ}54'E$) shows a smooth variation with latitude. At the December solstice, when the records were made, the region of maximum range is about 0.5° south of the magnetic equator. The form of the daily variation curve also varies with latitude; it is symmetrical close to the magnetic equator, and asymmetrical on either side. The changes can be explained as caused by the superposition of the effects of a narrow equatorial electrojet on a more general field.—*M. C. R.*

- 170-233. Przybyszewski, Eugeniusz. Comparison of La Cour magnetometers at the geophysical observatory on the Hel Peninsula: *Acta Geophys. Polonica*, v. 5, no. 1, p. 22-23, 1957.

The correction for the base line of the H magnetograph at the Świder observatory with respect to the mean of the three QHM magnetometers at the Hel Geophysical Observatory, Poland, is $+0.17\gamma$; that for the Z magnetograph base line with respect to the Hel BMZ-87 magnetometer is -28.15γ . The corrected differences in H and Z components between Świder and Hel for epoch 1954.8 are tabulated.—*D. B. V.*

MAGNETIC PROPERTIES

- 170-234. Blackett, P. M. S. *Lectures on rock magnetism*: 131 p., Jerusalem, The Weizmann Science Press of Israel, 1956.

This book is an expansion of the second series of Weizmann Memorial Lectures at Rehovoth in December 1954. The first chapter is a general introduction to the history, methods, and possibilities of studies of rock magnetism, particularly with respect to the magnetic field of the earth in the past and the movement of continents. The second chapter is a discussion of laboratory experiments on the origin of reverse magnetization, and the third an analysis of results available in the spring of 1956 pertaining to the history of the earth's field and the movement of land masses. A magnetic measuring instrument based on the axial extraction method developed by Pauthenet, a method of separating small quantities of magnetic materials, and a discussion of the thermal reversal of magnetically treated materials are given in three appendixes.—*M. C. R.*

- 170-235. Bucha, Václav. Magnetické vlastnosti hornin v. praktické geofysice [Magnetic properties of rocks in applied geophysics]: Czechoslovakia Ústřední ústav geol Věstník, ročník 31 číslo 1, p. 11-28, 1956.

A brief description of simple but sufficiently accurate methods of magnetic exploration written for practical geophysicists. After a short review of physical bases of the magnetism and the derivation of principal formulas, two procedures of determining the magnetic susceptibility and remanent magnetism of rocks are discussed: one for ferromagnetic substances, the other for weakly magnetic bodies (T. N. Roze's method.) In discussing the demagnetizing properties of

different bodies, the corresponding coefficients were derived for the sphere and the ellipsoid, and several examples are worked out. The magnetic properties of about 35 specimens of rocks from different parts of Czechoslovakia are tabulated.—S. T. V.

- 170-236. Mokhova, E. N. Raschet namagnichennosti prizmy pri postoyannoy vospriimchivosti [Numerical determination of the magnetization of a prism with constant susceptibility]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 680-682, 1957.

The magnetization of rocks is usually determined in laboratories on specimens of cylindrical or prismatic form. To determine the magnetic state of the rock in place, the approximate relation $I = \frac{KH}{1+KN}$, where N is the de-

magnetization factor, H is the external field, I is the magnetization in the middle section (if N is the ballistic demagnetization factor) or the average magnetic intensity over the volume of the specimen (if N is the magnetometric demagnetizing factor) and K is the magnetic susceptibility.

As most rocks have a very low value of K , it is natural to assume that this magnetization is nearly homogeneous, or that I is constant. Thus the field can be computed by Poisson's formula. Or it can be assumed that on all boundary surfaces the normal component I_n is either zero or constant. Thus the magnetic potential E is equal to $E = I_n ds/r$. By using the basic relations of the theory of electromagnetism, a rather cumbersome formula for I is obtained and numerical values are given for the ratio I/H for various values of K and several values of the ratio b/a , where b is the height and a the cross section of the investigated cylindrical or prismatic specimen.—S. T. V.

- 170-237. Taychinov, R. S. Issledovaniye vospriimchivosti i namagnichenosti nasyshcheniya osadochnykh porod v silnykh magnitnykh polyakh [Investigation of the susceptibility and the saturation magnetization of sedimentary rocks in strong magnetic fields]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 363-368, 1957.

The magnetic susceptibility of weakly magnetic sedimentary rocks is usually determined in weak magnetic fields and accurate results can not be obtained. Taychinov has used strong magnetic fields acting on a specimen placed at the point where the gradient of the magnetic field is a maximum. The magnetic force acting on the specimen was measured by the Saxsmith balance. From the coercive force and the magnetic susceptibility it is possible to determine with an error usually less than $\pm 0.4 \times 10^{-6}$ cgs units.

In such weakly magnetic substances as most sedimentary rocks, both diamagnetic and paramagnetic substances are usually present. The effect of non-ferromagnetic fraction on the magnetic susceptibility of the rock can be determined by the method of Honda and Owen. Measurements on argillites, reddish sandstone, weathered gneissoid granite, and gabbro on argillites.

It is assumed the magnetization of a weakly magnetized mineral or rock is determined exclusively by the amount of Fe_3O_4 percent, thus the magnetic parameters were determined and the inverse problem, the determination of the magnetite content in a rock, can be made from the graphs.—S. T. V.

- 170-238. Bol'shakov, A. S. *Stabil'nost' normal'noy namagnichennosti gornyykh porod* [Stability of the normal magnetization of rocks]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 585-607, 1957.

The effect of constant demagnetizing fields, alternating magnetic fields, and heating on the stability of natural magnetization of specimens of magnetite, pyrrhotite, and nickel was investigated. The stability of remanent magnetization under the action of constant field cannot be characterized by either the coercive force or by the coercive force of the saturation loop. The best characteristic of stability is the demagnetization curve, which should be determined in each case. For characterization of stability in an alternating field it is sufficient to determine the curve of demagnetization in the constant field, because of amplitudes greatly exceeding the intensity of the demagnetizing field are needed to destroy the stability.—S. T. V.

- 170-239. Graham, John W., Buddington, A. F., and Balsley, J. R. Stress-induced magnetizations of some rocks with analyzed magnetic minerals: Jour. Geophys. Research, v. 62, no. 3, p. 465-474, 1957.

Magnetostriction can be of major importance in interpreting measurements of the residual magnetism of rock samples. A description is given of the experimental procedures that were used to determine the influence of axial compression on the natural magnetizations of a variety of rock core samples whose magnetic minerals have been analyzed. Changing the stress from 350 to 2,650 psi caused a marked decrease in magnetic intensity of rocks containing magnetite or ilmenomagnetite, and a slight increase when the magnetic minerals are in the system $\text{FeTiO}_3\text{-Fe}_2\text{O}_3$. Directions of magnetization also changed, in a non-systematic manner. Inasmuch as many rocks acquire magnetization while under directed stress and are relatively stress-free when their magnetizations are measured, these results are offered as support of the opinion that many conclusions that have been offered on the basis of rock-magnetism data, relating to polar wandering, continental drift, secular variation, and reversal of the earth's magnetic field, are subject to serious doubt.—Authors' abstract

- 170-240. Irving, E. Rock magnetism: A new approach to some palaeogeographic problems: Advances in Physics, v. 6, no. 22, p. 195-218, 1957.

A discussion of the basic theory and theories involved in paleomagnetic studies and their application to investigations of polar wandering and continental drift.—J. R. B.

- 170-241. Runcorn, S. K.[eith]. The sampling of rocks for palaeomagnetic comparisons between the continents: Advances in Physics, v. 6, no. 22, p. 169-176, 1957.

If a suitable pattern of sampling is followed, only a score or so of specimens is required to determine the direction of magnetization of a particular lithology from one rock formation. The sampling pattern must be designed to eliminate the scatter in the direction of magnetization produced by imperfections in experimental techniques, failure of the rocks to become magnetized exactly in the field direction, deviation of the geomagnetic field from an axial dipole field, and movement of the pole of rotation with respect to the site position during the time represented by the rock formation. Greatly increasing the number of specimens measured above this minimum number confirms the direction of magnetization determined, but does not materially increase its precision.—J. R. B.

- 170-242. Nairn, A. E. M. Palaeomagnetic collections from Britain and South Africa illustrating two problems of weathering: *Advances in Physics*, v. 6, no. 22, p. 162-168, 1957.

Comparison of the direction of magnetization in samples of the Karoo basalt obtained from outcrops at the surface or shallow road cuttings show a much wider scatter than those collected from gorges and deep quarries; the difference confirms the theory that the post-Tertiary weathering observed in most of Africa has materially changed the direction of the remanent magnetization of the surface rocks. Similar comparisons of measurements made on Cave sandstone of Upper Triassic age from a borehole and from surface specimens show the same results.—*J. R. B.*

- 170-243. Irving, E. Directions of magnetization in the Carboniferous glacial varves of Australia: *Nature*, v. 180, no. 4580, p. 280-281, 1957.

The average magnetic inclination in varved sediments in the Upper Kuttung Series of New South Wales is 84° , which indicates that they were deposited in a high latitude. Pole positions consistent with the average direction of magnetization are near Lord Howe Island and Maderia, and thus at considerable distance from poles based on data from Great Britain and the United States. The disagreement suggests either that Australia has moved relative to Great Britain and the United States, or that the geomagnetic field was approximately dipolar over a large part of the northern hemisphere but not so in the southern hemisphere.—*M. C. R.*

- 170-244. Irving, E. and Green, R. Paleomagnetic evidence from the Cretaceous and Cenozoic: *Nature*, v. 179, no. 4569, p. 1064-1065, 1957.

A paleomagnetic study of two groups of mafic rocks in Victoria, Australia, indicates that continental movements (meridional translations, or rotations) have been negligible in Pleistocene and Recent time but took place during Tertiary time. Conclusions are based on 32 samples of Newer Volcanics from an area of 10,000 sq miles, and 15 samples of Older Volcanics from an area of 4,000 sq miles.—*M. C. R.*

- 170-245. Belshé, J. C. Recent magnetic investigations at Cambridge University: *Advances in Physics*, v. 6, no. 22, p. 192-193, 1957.

The mean direction of the magnetization of Jurassic rocks from Dorset and Devon is $N 15^\circ E$ and 54° down for Bridport Sands and $19^\circ W$ and 56° down for the Northants Iron-stones. When heated above the Curie temperature and cooled in the field of 0.6 oersted, samples of the Old Red Sandstones from Brecon Beacons showed a thermal remanent magnetization on the order of half of normal their remanent magnetization.—*J. R. B.*

- 170-246. Belshé, J. C. Palaeomagnetic investigations of Carboniferous rocks in England and Wales: *Advances in Physics*, v. 6, no. 22, p. 187-191, 1957.

An attempt was made to establish a detailed "type section" of magnetic measurements in the Carboniferous rocks in England and Wales. After early measurements has yielded consistent results, several hundred additional samples from Derbyshire, Lancashire, and Wales confirmed the magnetic direction of $N 27^\circ E$ and 36° down but the later data had a much wider scatter than the earlier.—*J. R. B.*

- 170-247. DuBois, P. M. Comparison of palaeomagnetic results for selected rocks of Great Britain and North America: *Advances in Physics*, v. 6, no. 22, p. 177-186, 1957.

Comparison of the positions of the magnetic pole determined from measurements on rocks of Precambrian, Permian and Upper Triassic age from the United States and Europe all show a westward displacement; the displacement amounts to 45° for all the pole positions plotted from the United States data. Apparently prior to Triassic time the two continents maintained their relative position but since Triassic time the United States has drifted 45° west with respect to Great Britain.—*J. R. B.*

- 170-248. Clegg, J. A., Deutsch, E. R., Everitt, C. W. F., and Stubbs, P. H. S. Some recent palaeomagnetic measurements made at Imperial College, London: *Advances in Physics*, v. 6, no. 22, p. 219-231, 1957.

The mean directions of magnetization of Carboniferous igneous rocks and the sedimentary rocks that they have heated are N 218° to 200° E and 15° to 38° down, considerably different than the results reported by Belshé (see *Geophys. Abs.* 170-246). Because country rocks overlying an igneous mass whose origin was in question show a much higher magnetization in a direction more consistent with that in the igneous rock than in the country rock removed from the contact, it is believed that the igneous mass must have been intruded rather than extruded. Measurement of the direction of magnetization of several hundred additional samples of the Deccan Traps taken from four areas are in broad agreement with previously reported measurements on these rocks. The mean directions range between 140° and 176° in azimuth and 57° to 59° down; reversals have an azimuth of 335° to 357° and dips of 30° up to 15° down.—*J. R. B.*

- 170-249. Roche, Alexandre. Sur l'aimantation des roches volcaniques de l'Estérel [On the magnetization of the volcanic rocks of the Estérel]: *Acad. Sci. Paris Comptes Rendus*, tome 244, no. 24, p. 2952-2954, 1957.

The magnetization (inclination, declination, and stability) has been measured on 16 samples of 5 volcanic rocks from the Estérel area in France. The Permian rocks are weakly and inversely magnetized; the esterellites, age uncertain, are normally magnetized with an inclination analogous to that usually found in Tertiary and Quaternary rocks.—*D. B. V.*

- 170-250. Rutten, M. G., Everdingen, R. O. van, and Zijdeveld, J. D. A. Palaeomagnetism in the Permian of the Oslo Graben (Norway) and of the Estérel (France): *Geologie en Mijnbouw*, 19^e jaarg., no. 6, p. 193-195, 1957.

The Permian lavas of the Oslo graben and of the Estérel area in southeastern France are about $16\frac{1}{2}$ degrees of latitude apart and have been only slightly tilted in later block-faulting. Three basalts and 13 trachyandesites (rhomboporphyries) from the Krogskogen area in the Oslo graben all show reverse remanent magnetization; their average remanent magnetization is 40×10^{-5} cgs units (maximum 3.8×10^{-3} , minimum 0.6×10^{-5}). Their average direction of magnetization is declination S $21^\circ 40'$ W and inclination of $-33^\circ 04'$, corresponding to a north magnetic pole some 1200 km southwest of Kamchatka at lat $45^\circ 40'$ N and long 165° E. Samples from the R₃ rhyolite flow of the Estérel area also all show reverse magnetization; their remanent magnetization is weaker, averaging

28×10^{-6} cgs units (maximum 15×10^{-4} , minimum 4.72×10^{-6}). Average direction of magnetization is declination S 37° W and inclination -22.5° , corresponding to a north pole in China at long $130^\circ 31'$ E and lat 45° N. The pole deduced from the Oslo rocks corresponds well with the Permian pole found by Creer in England (see *Geophys. Abs.* 163-32) whereas that deduced from the Estérel rocks lies closer to the Permian poles found by Runcorn and Doell in the United States (see *Geophys. Abs.* 165-273 and 164-234). It is very tentatively suggested that possibly the Estérel rhyolites are enough older to come into the neighborhood of the European pole for the Carboniferous.—*D. B. V.*

170-251. Angenheister, Gustav. Über die Magnetisierung der Basalte des Vogelsberges [On the magnetization of the basalts of the Vogelsberg]: *Akad. Wiss. Göttingen Nachr., Math.-phys. Kl., Abt. 2a, Heft 9*, p. 187-204, 1956.

Measurements of the intensity and direction of the natural remanent magnetization of 43 basalt flows of the Vogelsberg (Germany) indicate a position of the geomagnetic pole during Tertiary time in good agreement with those calculated by other authors.—*D. B. V.*

170-252. Einarsson, T[rausti]. Magneto-geological mapping in Iceland with the use of a compass: *Advances in Physics*, v. 6, no. 22, p. 232-239, 1957.

By using the compass it is possible to determine the direction of magnetization of lavas observed in field mapping. In the older rocks where the magnetization is weak, the contact material, including the underlying burnt sediment, the basal scoriae, and the lowest few centimeters of the lava, generally have a sufficiently high magnetization that its direction can be determined by this means. Such studies in Iceland show that there is a fundamental regularity in the magnetization and that lavas are arranged in well defined groups of alternately normal and reversed polarity, with clear and significant transition zones between successive groups, usually a sedimentational or erosional hiatus. Within each magnetic group various kinds of magnetic material all have the same polarity. There is no systematic vulcanological or petrographical difference between normal and reversed rocks, so the fundamental regularity seems to be naturally explained by reversal of the geomagnetic field. In one column, 4.7 kilometers thick, consisting of 13 groups of an average thickness of 340 meters, the total thickness of the normal group is 2,175 meters and that of the reversed, 2,250 meters, indicates an almost equal distribution of the two directions. The work conducted so far indicates that there were more than 30 magnetic periods during the Tertiary—that is, 30 changes in direction.—*J. R. B.*

170-253. Einarsson, Trausti. Der Paläomagnetismus der islandischen Basalte und seine stratigraphische Bedeutung [The paleomagnetism of the Icelandic basalts and its stratigraphic significance]: *Neues Jahrb. Geologie u. Paläontologie Monatsh., Jahrg. 1957, Heft 4*, p. 159-175.

The direction of remanent magnetization has been measured in a series of stratigraphic columns in Iceland consisting largely of layers of basalt and related rocks. All the post-glacial and late Quaternary basalts are normally magnetized. A reversal occurs in the lower Quaternary near the Pliocene-Pleistocene boundary. In the Tertiary sequence of west central Iceland, concordant layers of

plateau basalt are differentiated into mappable units according to direction of magnetization (normal or reverse). Mapping on this basis is suggested as a supplement to other methods, in general, and in places like Iceland, where sedimentary layers are thin and very similar in appearance, it is definitely easier to map on the basis of magnetization rather than petrography of lavas, and in plateau basalts it is quicker and more accurate. The remarkable parallelism between the Quaternary profiles for Iceland and other countries suggests the possibility of long distance correlation of Quaternary volcanic rocks, and eventually perhaps even of Tertiary rocks.

Pole positions were calculated for 33 samples with normal and 26 with reverse magnetization from within 6 different groups, and found to lie anywhere from near the present poles to 50° away ($\pm 17^\circ$ for the south pole, $\pm 18^\circ$ for the north). The average latitude of the south pole is $73.9^\circ \pm 2.8^\circ$; that of the north pole, at $87.8^\circ \pm 3.6^\circ$, corresponds more closely to the geographic pole. Transition zones between normally and reversely magnetized layers were studied, inconclusively, in 7 profiles. The change seems to have been accomplished over centuries, or at most a few thousand years. Few intermediate pole positions were found, and those only at boundaries of groups.—*D. B. V.*

170-254. Sigurgeirsson, Th. Direction of magnetization in Icelandic basalts: *Advances in Physics*, v. 6, no. 22, p. 240-246, 1957.

Magnetic pole positions determined from study of 33 samples of Icelandic basalts showing normal magnetization and 26 samples showing reversed magnetization, are distributed around the geographic pole down to the latitude of 50° ; the probable error for the reversed poles is 17° and for the normal poles 18° . The probable error of the position of the poles calculated from geomagnetic data of 20 magnetic observatories scattered over the earth is only 8° . In seven places mapped by Einarsson (see *Geophys. Abs.* 170-252) intermediate directions of magnetization have been found between two groups of flows with opposite directions of magnetization. Samples from six of these places have been studied; if the pole positions for the rocks at four of the locations are plotted on the globe a regular path, which apparently was followed by the magnetic pole during the reversal of the field, is indicated.—*J. R. B.*

170-255. Graham, K. W. T., and Hales, A. L. Palaeomagnetic measurements on Karroo dolerites: *Advances in Physics*, v. 6, no. 22, p. 149-161, 1957.

The measurements of the direction of magnetization of samples of the Jurassic Karroo dolerites collected from two shafts near Kinross, Transvaal, South Africa show that the upper sill is magnetized in the direction reverse to the present field and another sill, 750 feet lower, is magnetized in the normal sense. Similar measurements in a complex series of sills exposed in a railroad tunnel near Estcourt, Natal, show that the dolerite and baked sediments are normally and reversely magnetized. One dike has a chill zone that is normally magnetized whereas the interior of the dike and the baked sediments are magnetized in the reverse sense. This difference may have resulted because the chill zone was unstable or because a self-reversing mechanism operates in the chill zone.

The position of the magnetic pole inferred from measurements on these dolerites are not consistent with those inferred from rocks of the same age in Europe, America, and Australia. The difference may have been produced by relative

displacements of the continents, but more accurately dated measurements covering a larger portion of the stratigraphic column are necessary to describe with any confidence the possible drift path of the continent.—*J. R. B.*

- 170-256. Kintzinger, Paul R. Paleomagnetic survey of Triassic rocks from Arizona: *Geol. Soc. America Bull.*, v. 68, no. 7, p. 931-932, 1957.

The mean directions of magnetization of the Dinosaur Canyon and Moenkopi formations are: declination, N 21° E and N 35° W; inclination, +30° and +35°.—*M. C. R.*

MAGNETIC SURVEYS

- 170-257. Sokolov, K. P. *Geologicheskoye istolkovaniye magnitorazvedochnykh dannyykh* [Geologic interpretation of the data obtained from magnetic surveying]: 128 p., Moscow, Gosgeoltekhizdat, 1956.

A manual of the procedures to be followed in analyzing and interpreting the data obtained in magnetic surveys.—*S. T. V.*

- 170-258. Whitham, K[enneth], and Loomer, E. I. Irregular magnetic activity in northern Canada with special reference to aeromagnetic survey problems: *Geophysics*, v. 22, no. 3, p. 646-659, 1957.

An investigation of the diurnal and seasonal characteristics of irregular magnetic activity in northern Canada, using two indices of disturbance, shows that in general the *K* index provides a reliable but smoothed measure of short period activity. Two peaks of activity are evident, a day-time peak, dominant inside the polar cap, and a night peak, dominant south of the auroral zone. The latter occurs within one hour of local geomagnetic midnight at four Canadian observatories, whereas the day-time peak occurs progressively later at higher latitudes. The maximum activity occurs in the equinoxes at latitudes near the auroral zone, and during the summer solstice at very high latitudes.

Measurements of range at the most disturbed observatory suggest that aeromagnetic surveying in high latitudes is in general feasible, but that for accurate reconnaissance work it is very advantageous to plan operations, so far as conditions permit, taking account of the systematic diurnal variation of disturbance. It is shown that errors of about one half the assumed diurnal change between base lines will occur and sufficient data is given to allow approximate predictions of the optimum length of flight lines.—*Authors' abstract*

- 170-259. Malmquist, David. Eine elektromagnetische Methode zur Bestimmung der elektrischen Leitfähigkeit und magnetischen Permeabilität von Bohrkernen [An electromagnetic method of determining the electrical conductivity and magnetic permeability of drill cores]: *Freiberger Forschungshefte*, C 32 *Geophysik*, p. 20-39, 1957.

A description of a method and apparatus for determining relative magnetic flux in cylindrical or semicylindrical core samples. A formula is derived for calculation of electrical conductivity and magnetic permeability from the relative magnetic flux, for an infinite homogeneous cylinder. Empirical corrections must then be applied for finite cylinders or half-cylinders. The results of measurements on 6 cylindrical and 6 semicylindrical ore-bearing cores from mines in the Skellefte region in Sweden are tabulated. Accuracy is not very high,

but the method is simple and the conductivity can be determined for metal or mineral grains more or less isolated in the matrix—*D. B. V.*

- 170-260. Peloschek, H. P. Contributions to the geology of Timor XI. Reports on magnetic observations and radioactive measurements in Indonesian Timor: Indonesia Madjalah Ilmu Alam, v. 112, pt. 2 p. 175-184, 1956.

Magnetic measurements were made in 1954 on Indonesian Timor using 2 Ruska Type V magnetometers. A vertical component profile across the Nikiniki fault shows no effect attributable to the fault, and a small but definite maximum that does not correspond to any geological feature visible at the surface; therefore the source of the magnetic anomalies must lie deeper than the upper layer. Northwest of Kefamenanu a remarkable anomaly was observed on an outcrop of Permian pillow lava, in which the *Z* component varied 7,000 gammas in a distance of 250 m.

Radioactive measurements made during the same expedition show an average background count of 36-38 counts per minute at ground level, somewhat lower at 30 cm above the ground, and an average of 28 counts per minute at sea. The Nikiniki fault is not reflected in the radioactivity measurements. Counts were highest on Pulau Kambing (average 49 counts per minute), probably because that island is entirely built up of material ejected from deeper levels.—*D. B. V.*

Meyer, V. A. Application of geophysical logging on polymetallic ore deposits. See *Geophys. Abs.* 170-135.

MICROSEISMS

- 170-261. Donn, William L. A case study bearing on the origin and propagation of 2- to 6-second microseisms: *Am. Geophys. Union Trans.*, v. 38, no. 3, p. 354-359, 1957.

Study of microseism amplitudes at seven east coast and island stations for the hurricane of September 1-13, 1950 indicates that generation of microseisms is poor over oceanic areas (such as the abyssal plains) where the crust has a uniform thickness but is efficient where the thickness changes rapidly. Efficient propagation seems to be limited to the crustal medium or layer in which generation occurs. A theory is proposed that such microseisms are generated by waves breaking at sea. The energy would produce a very high random noise level in the ocean; the ocean, probably including the loose bottom, would act as a filter in transmitting the energy, which would result in some period-depth relation.—*M. C. R.*

- 170-262. Jensen, Henry. On the beat-distribution in group-microseisms: *Denmark Geod. Inst.*, no. 34, 27 p., 1957.

Microseisms in the period range of 4-9 seconds recorded at the Danish station of Scoresbysund and København show a beat phenomenon, the interval of which has a log normal distribution with only one parameter, as which the simple mean may be chosen. The mean value of the beat interval is proportional to the period of the carrier wave. As the beat interval is greater in the vertical records than in horizontal records, it is assumed that there are some Love waves present.—*M. C. R.*

- 170-263. Upton, P. S. Cyclone microseisms at Brisbane: Queensland Univ. Dept. Geology Papers, v. 4, no. 14, 12 p., 1956.

A new method of measuring microseism amplitudes that could be used to obtain early warning of the development of a cyclone was tested by application to records of two cyclones in March 1955. For distances of more than 250 miles, the microamplitude is inversely proportional to the square root of the distance from the source and, when the amplitude-distance factor is plotted against pressure, it is evident that a small change in pressure at the center has a great effect on microseism amplitude.—V. S. N.

RADIOACTIVITY

- 170-264. Arrhenius, G., Bramlette, M. N., and Picciotto, E. [E.]. Localization of radioactive and stable heavy nuclides in ocean sediments: *Nature*, v. 180, no. 4576, p. 85-86, 1957.

Distribution of α -activity in sediments from the north equatorial Pacific was studied by suspension of sediment in liquid nuclear emulsion. Results indicate 10 percent of the α -tracks originate from small crystals, possibly barite; 15 percent in aggregates that may be fecal pellets of benthonic animals; 25 percent with fragments of fibrous apatite and organic matter, the skeletal debris of fish; and the remaining 50 percent from radioactive matter in true or colloidal solution in the pore water of the sediment or displaced from the solids of the sediment.—M. C. R.

- 170-265. Aramu, Francesco, and Uras, Ivo. Alcuni risultati su una analisi di radioattività naturale dei carboni del Sulcis [Some results of an analysis of the natural radioactivity of the coals from Sulcis]: *Soc. mineralog. Italiana Rend.*, anno 13, p. 114-119, 1957.

Results of nuclear emulsion measurements of the natural radioactivity of 31 coals, 1 trachyte, 1 andesite, and 1 marly limestone from the Seruci and Serbariu mines in the Sulcis coal basin, Sardinia are presented. For each sample the location, specific activity, thorium content, and uranium content are tabulated. The mean concentrations in grams per gram are as follows: Seruci mine, thorium= 5.66×10^{-6} , uranium= 2.33×10^{-6} ; Serbariu mine, thorium= 4.56×10^{-6} , uranium= 1.87×10^{-6} . The Carboniferous rocks of the basin may be considered a potential reserve of uranium.—D. B. V.

- 170-266. Mahadevan, C. Investigations on the age of Madras granites and south Indian rocks: *Geological Time*, Council of Sci. Indus. Research [India], Comm. on Measurement of Geol. Time in India, p. 7-11, 1954.

On the basis of investigations of the radioactive Nellore samarskite, the age of the Eastern Ghats pegmatitic cycle in South India was computed to be $1,600 \pm 50$ million years. Radioactivity data from the Kolar Gold Field rocks of this area show that the radioactivity of schists and dikes increases with depth, the mica-pegmatites show the highest radioactivity, and the radioactivity of pegmatites is variable but not in relation to depth.

A study of the radioactivity of charnockites and associated rocks from four areas roughly 200 miles apart shows that the radioactive content of a rock suite of a particular area is related to its petrogenetic history.

Investigation of ocean bottom sediments shows that the radioactivity of deep sea sediments is markedly higher than any other group and that distribution of radioactivity in deltaic sediments is influenced by the nature of the formations in the drainage basin of the river responsible for the sediments.—*V. S. N.*

- 170-267. Sastry, A. V. R., and Aswathanarayana, U. Distribution of radioactivity in the rocks of south India: Part III.—Charnockites and associated rocks of Yercaud-Salem area of Madras State: Jour. Sci. Indus. Research (India), v. 16B, no. 3, p. 99-101, 1957.

The radioactivity of 7 charnockites, 7 of the Kunnankurichchi interaction rocks, and 13 diopside-hornblende gneisses from the Yercaud-Salem area in Madras State, India, has been measured and the results analyzed from the mineralogical and petrogenic points of view. The radioactivity of the charnockites seems to be associated with alkali feldspars, particularly the potassium feldspars; that of the hybrid rocks and gneisses correlates with mafic mineral content. The average radioactivity of the intermediate charnockites in the Yercaud region (5.37×10^{-6} eU per g) is lower than that of intermediate charnockites studied earlier (6.74×10^{-6} eU per g) (see Geophys. Abs. 164-256), though of the same order of magnitude. The Kunnankurichchi rocks have an average radioactivity intermediate between the charnockites and gneisses (2.23×10^{-6} eU per g), which supports the field evidence that they have been formed by intermingling of both types of material. The radioactivity of the Salem gneisses is low, averaging 1.08×10^{-6} eU per g; this is unexpected in view of the granitic aspect of most of their members. They could have been produced by simple recrystallization of weakly radioactive rocks without introduction of material capable of influencing the distribution of radioactivity.—*D. B. V.*

- 170-268. Mahadevan, C., and Aswathanarayana, U. Radioactivity of charnockites and their petrogenesis: Pan Indian Ocean Sci. Cong. Proc., Sec. C, Geology, p. 47-49, 1954.

The radioactivity of charnockites and associated rocks from the Ananthagiri, Kondapalli, Pallavaram and Trichinopoly areas in south India is closely related to the order of decreasing mafic content. The marked contrast in radioactivity of the four suites of rocks reflects the difference in petrogenetic processes responsible for their formation. See also Geophys. Abs. 170-266.—*V. S. N.*

Peloschek, H. P. Contributions to the geology of Timor XI. Reports on magnetic observations and radioactive measurements in Indonesian Timor. See Geophys. Abs. 170-260.

- 170-269. Rosen, R. Note on some observations of radon and thoron exhalation from the ground: New Zealand Jour. Sci. Technology, sec. B, v. 38, no. 6, p. 644-654, 1957.

Measurements of radon exhalation from the ground have been made by a modified induction method, in which the decay of products on the collector wire is recorded by a gauze cylindrical ion chamber situated around the wire. Measurements from June to August 1955 (at a site in Wellington, New Zealand) showed an average exhalation rate of approximately 0.2×10^{-18} curies $\text{cm}^{-2} \text{sec}^{-1}$. During periods of decreasing atmospheric pressure, there was usually a slight increase in the exhalation rate. There was a marked decrease during rainfall. The results also indicated a diurnal variation in the exhalation rate. The radon thoron ratio was found to be about 1.5.—*Author's summary*

RADIOACTIVITY LOGGING AND SURVEYING

- 170-270. Voskoboynikov, G. M. Teoreticheskiye osnovy selektivnogo gamma-gamma-karotazha [Theoretical bases of selective gamma-gamma well logging]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 351-362, 1957.

In gamma-gamma well logging, the recorded intensity of secondary radiation from any substance is determined in general by its density and chemical composition. Through a rational modification of the parameters and the design of the probe it is possible to reinforce either of these properties. Using soft rays and an adapted construction of the probe, great sensitivity is obtained, so that a small admixture in the rock of elements with high atomic numbers, which are not detectable on the density of the rock, can be detected. This method of well logging, in distinction from the known density gamma-gamma well logging, is called selective gamma-gamma well logging. Selective well logging can be used in exploration for deposits of the heavy metals; bismuth, lead, mercury, tungsten, antimony, tin, and under certain favorable conditions can also be used in exploration for molybdenum, zirconium, and niobium.—*S. T. V.*

- 170-271. Ochkur, A. P. Karotta h plotnosti [Density logging by γ -rays]: Vses. nauchno-issled. inst. razved. geofiz. Voprosy rudnoy geofiz., Sbornik statey 1, p. 62-68, 1957.

A discussion of the method of determining the density of the formations pierced by a drill hole by using radioactivity logging. The method is based on the constant correlation between the density of the rock and the ratio of the irradiating and reflected energies. Comparison of the results of many experiments with those obtained from lithological coring indicated good agreement.—*S. T. V.*

Meyer, V. A. Application of geophysical logging on polymetallic ore deposits. See Geophys. Abs. 170-135.

- 170-272. Hilpert, L. S., and Bunker, C. M. Effects of radon in drill holes on gamma-ray logs: Econ. Geology, v. 52, no. 4, p. 438-455, 1957.

Discrepancies in duplicate gamma-ray logs of drill holes in uranium deposits in the Todilto limestone near Grant, N. Mex., were found to be caused by contamination by radon and its daughter products. Most contaminated holes were in higher grade ore and contamination increased with elapsed time after drilling.

Conditions favorable for radon contamination in drill holes are proximity to uranium deposits and fractured or permeable rocks above the water table. Most drill holes can be decontaminated by blowing them out with compressed air or by filling with water, although in this area water reduced the total thickness-times-grade figures by about 20 percent. Holes should be logged immediately after drilling to avoid most contamination effects.—*V. S. N.*

- 170-273. Winn, R. H. Log interpretation in heterogeneous carbonate reservoirs: Texas Petroleum Research Comm. Bull., no. 58, p. 1-17, 1957.

A progress report on the development of a method of evaluating heterogeneous carbonate reservoirs from gamma, neutron-gamma, caliper, and focused resistivity surveys. The logs are compared with core analysis data and analysis of the surveys compared with production data to establish improved analytical

techniques for determining the net oil in place in the layers of the reservoir.—*V. S. N.*

- 170-274. Mercier, V. J., and Redford, W. H. New calibration and conversion techniques for radioactivity logs: Texas Petroleum Research Comm. Bull., no. 58, p. 18-29, 1957.

New calibration techniques for radioactivity logs makes possible rapid analysis and evaluation of the logs. The application of standardized units to each log regardless of detector type, source spacing, or well conditions is explained and neutron curve conversion charts are introduced.—*V. S. N.*

- Burge, Edgar. Selected problems in well log correlations. See *Geophys. Abs.* 170-127.

- 170-275. Kellogg, William Crowe. Observation and interpretation of radioactive patterns over some California oil fields: *Mines Mag.*, v. 47, no. 7, p. 26-28, 1957.

The anomalies measured in airborne radioactivity surveys over the Ten Section oil field and the Tejon Grapevine field in Kern County, Calif., are explained in terms of the deposition of radioactive salts at the earth's surface by ground water. The movement of ground water is influenced by geology (such as faults, bedding planes, zones of porous and permeable material, or attitude of the strata), so that geologic structure may be revealed by radioactivity anomalies.—*L. C. P.*

- 170-276. Sato, Mitsunosuke, Iwasaki, Syōji, and Sano, Shun'ichi. The airborne radiometric surveying in the southern parts of Okayama Prefecture and in the central parts of Tottori Prefecture: *Geol. Survey Japan Bull.*, v. 7, no. 10, p. 15-30, 1956.

The first airborne radiometric surveys in Japan were made over the Miyoshitungsten mine, Okayama Prefecture, and the Ogamo gold mine, Tottori Prefecture. The ores occur in quartz veins in biotite granite and are associated with radioactive minerals. A portable scintillation counter, essentially a rate-meter with a variable time constant, was developed for these surveys. Because of the complex undulations of the topography, flights were made without regard to small changes and a procedure of altitude correction based on the following geologic concept was adopted: anomalous increase of radioactive intensity extends to an area of more than one square kilometer around the deposit bearing uranium minerals and the relation between radiation intensity in the air and altitude above the terrain may be expressed by a semi-infinite body having homogeneous distribution of radioactive components. By using the formula of C. A. Godby, Geological Survey of Canada, the relation between intensity and altitude may be calculated if the value of effective absorption coefficient of air for natural radioactive components is assumed to be between 3×10^{-5} cm and 4×10^{-5} cm.

Several anomalous areas were discovered and ground surveys will be made to check the existence of actual deposits.—*V. S. N.*

- 170-277. Daly, J., and Dyson, D. F. Geophysical investigations for radioactivity in the Harts Range area, Northern Territory: Australian Bur. Min. Resources Geology and Geophysics Rept., no. 32, 22 p., 1956.

A portable Geiger-Müller ratemeter was used to test for radioactivity in 60 mica mines in the Harts Range area. Two classes of occurrence were found: those in which specific radioactive minerals, such as samarskite, betafite, large pieces of crystalline monazite, and finely disseminated radioactive minerals, could be identified by radiometric tests on concentrates or by visual methods; and those in which the radioactive material could not be identified including numerous slight enrichments all over the area in the biotite gneiss and mica schists. Tests reveal the minerals of the latter class are uranium minerals, probably intimately associated with the mica content of the rock. No economic tonnages were indicated.—V. S. N.

- 170-278. Woodmansee, W. C. Radiometric reconnaissance of copper mines dumps, northern Yorke Peninsula: South Australia Dept. Mines Min. Rev., no. 102, p. 76-83, 1957.

A radiometric investigation of mine dumps in the Moonta-Kadina copper-mining district and of 17 other copper prospects on northern Yorke Peninsula, South Australia, has shown that anomalous radioactivity is associated with many of the copper mineral deposits throughout the region. Three widely separated copper workings, the Hancock shaft, Penang copper mine, and Hillside copper mine, have been recommended for drilling because of favorable surface showings of uranium minerals. A low-level airborne radiometric survey on a regional scale has also been recommended because the association of the uranium minerals with copper could be a significant factor in exploration for copper.—V. S. N.

SEISMIC EXPLORATION

- 170-279. Starodubrovskaya, S. P. Opyt trassirovaniya pogrebennykh narushennykh zon po dinamicheskim kharakteristikam prelomlennykh voln [Experiences from an attempt to locate the buried faults through the dynamic characteristics of refracted waves]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 553-567, 1957.

The possibility of tracing fault zones by using the method of correlated high-frequency refracted waves was studied during 1951-1952 by the Geophysical Institute of the Russian Academy of Sciences. The results indicated that such zones can be mapped by using as an indicator a much lower limiting velocity of refracted waves in comparison with that in undisturbed zones. Thus in undisturbed formations of ferrous hornstone the seismic velocity is 4,500-5,000 m per sec, whereas over the disturbed zones this velocity is only 2,500-3,000 m per sec. Similar ratios were obtained for every formation. Numerous seismograms obtained during this survey are shown.—S. T. V.

- 170-280. Malinovskaya, L. N. O dinamicheskikh osobennostyakh prodol'nykh otrazhennykh voln za kriticheskimi uglami [On the dynamic characteristics of longitudinal reflected waves beyond the critical angle]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 569-574, 1957.

The author computed the theoretical seismograms of longitudinal reflected waves for three and four-layer medium at angles of incidence from 10° to 80°,

for four ratios of seismic velocities, ranging from 1/1.3 to 1/4.8, and density ratios from 1/1.13 to 1/1.3. For angles of incidence exceeding the critical angle the amplitudes of the reflected waves were greater than those of the initial incoming waves, and observed in 1954 by Yepinat'yeva in an actual survey.—*S. T. V.*

- 170-281. Vasil'yev, Yu. I. Izuchenije obmennyykh prelomlennykh voln pri seysmicheskoy razvedke [Study of converted refracted waves in seismic exploration]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 301-318, 1957.

Experiments were made under the auspices of the Russian Academy of Sciences in 1954 on refracted waves propagated along the refracting boundary as longitudinal waves or as transverse waves. The purpose of these to establish a methodology making possible the simultaneous use of longitudinal, converted, and transverse refracted and reflected waves in seismic exploration. Two questions were of interest, whether the converted and transverse waves have sufficient intensity to permit reliable measurement, and the possibility of their separation. A theoretical evaluation of the expected intensity of converted waves was made. Certain features of a more appropriate methodology have been established. The question of identification of these waves and the determination of the boundaries on which the change of type of wave takes place have been established. Vasil'yev concludes that the obtained results are very promising and indicate further study is warranted.—*S. T. V.*

- 170-282. Gates, John P. Descriptive geometry and the offset seismic profile: Geophysics, v. 22, no. 3, p. 589-609, 1957.

An illusion is created in attempting to portray steeply dipping seismic data by standardized geometric procedures. The offset seismic profile, although resembling the vertical geologic cross section in appearance, may have an inherent tilt which is a function of cross-dip. Unless this tilt is accounted for during the solution of critical structural problems, serious errors can enter into the interpretation of the seismic data. Descriptive geometry procedures are applied to establish the title and determine its effects on fault traces, structural axes, and well ties.—*Author's abstract*

- 170-283. Shima, Etsuzo. Note on the depth calculation by the seismic refraction method [in Japanese with English summary]: Butsuri-Tankō, v. 10, no. 1, p. 16-18, 1957.

A discussion of errors in calculated depth, if a structure of three horizontal layers is assumed to be only two layers and $V_0 < V_1 < V_2$.—*M. C. R.*

- 170-284. Erath, Louis W. Direct recording vs. FM recording in seismic tape machines: Geophys. Prosp., v. 5, no. 2, p. 151-164, 1957.

This paper describes the two methods of magnetic tape recording [frequency modulation and bias or direct recording] used today in the seismic industry. It discusses objectively the characteristics of both methods including historical material, discussion of circuitry, magnetic tape, drive systems, effects of flutter and harmonic distortion, signal transfer and tape transport construction. The paper also includes discussion of noise and reproduction of transient signals. Diagrams illustrating the two recording systems, their frequency response and

phase shift characteristics, distortion and noise levels as well as typical wave forms, are also attached.—*Author's abstract*

- 170-285. Sacks, I. S. A low-noise transistorized seismic preamplifier: Jour. Geophys. Research, v. 62, no. 2, p. 267-278, 1957.

Ground noise of the order of 10^{-9} cm will result in outputs of 1×10^{-7} volts from electrodynamic seismometers now being used. Internal vacuum tube noise usually exceeds 5×10^{-7} volts in the frequency range 2 to 30 c and for this reason and to cut power requirements, a transistorized preamplifier was designed. Noise measurements of p-n-p transistors were made using the common emitter transistor connection. Analysis of the noise measurement show that in the range of 4 to 35 c a noise voltage of 1.66×10^{-7} can be expected if optimum base and collector voltages are used. The major limitation of the design is the temperature dependence of the collector potential. This limitation is met by burying the preamplifier at a depth of 8 inches so that it is not subjected to temperatures exceeding 24°C .—*W. J. D.*

- 170-286. Gol'tsman, F. M. Primeneniye lineynkh sistem dlya fil'tratsii slozhnykh kolebaniy [The use of linear systems for filtering composite oscillations]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 584-594, 1957.

The analysis of vibrations with complex wave shape is greatly facilitated by use of filters that eliminate partial waves of different frequencies. The problem of designing a universal filtering arrangement, applicable to an incoming wave of any shape, is discussed. The theory of a filter of low frequency, high frequency, and the most general filter capable not only of suppressing certain undesirable waves but also of producing additional wave components of desired shape is worked.—*S. T. V.*

- 170-287. Manfredini, Antonio. Apparecchiatura sismica per problemi di ingegneria civile [Seismic apparatus for civil engineering problems]: Servizio geol. Italia Boll., v. 78, fasc. 3, p. 495-502, 1956.

Describes a light portable refraction apparatus suitable for the shallow depths involved in civil engineering problems. The instrument is similar to that described by Gough (see Geophys. Abs. 149-13710) but differs in regard to the electronic devices for direct measurement of time. The seismic impulse is provided by a blow of a 7-kg hammer, eliminating the need for explosives. The position of the hammer can be changed while the seismograph remains at a fixed point, or the hammer can stay at one point while the seismograph is moved to new positions; the former method is preferred where terrain permits. Under favorable conditions, the effective depth is 100 meters.—*D. B. V.*

- 170-288. Borisevich, E. S. Opticheskaya sistema dlya fotozapisi kolebatel'nykh processov [Optical system for the photo-recording of oscillatory processes]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 331-340, 1957.

A description of an optical system used in many magnetoelectric oscillographs of Russian and foreign make. It is simple, economical in consumption of current, and gives satisfactory quality of the records of oscillatory processes. Pictures and diagrams are included, and formulas are derived to make it possible to obtain the desired parameters of the instrument and time of exposure.—*S. T. V.*

- 170-289. Khalevin, N. I. Upornoye soprotivleniye dlya seysmografa pri seysmokratyazhe [Clamping brace for the seismograph to be used in well logging]: *Razvedochnaya i promyslovaya geofizika*, vypusk 14, p. 22-34, 1955.

To provide a good contact between the seismograph and the walls of the drill hole, the use of two flat springs of steel attached from two sides to the lower part of the seismograph is suggested. The pressure of the springs must be released before the seismograph is removed.—*S. T. V.*

- 170-290. Breck, H. R., Schoellhorn, S. W., and Baum, R[obert] B. Velocity logging and its geological and geophysical applications: *Am. Assoc. Petroleum Geologists Bull.*, v. 41, no. 8, p. 1667-1682, 1957.

Continuous velocity logging has been used in more than 900 wells to date. The velocity, measured over short intervals, is a function of the elastic properties of the formations logged and is affected mainly by degree of compaction and geologic age. The velocity log provides information for correlation, stratigraphic and lithologic identification, and porosity and fluid content studies. The velocity log also provides accurate and detailed velocity information that is of use in seismic reflection identification, computation of reflection depths, and laboratory studies of synthetic seismic reflections.—*L. C. P.*

- 170-291. Quarta, F., and Maino, C. Quelques considerations sur les mesures de vitesse effectuées dans les puits par l'Agip Mineraria en Italie et spécialement dans la plaine du Po [Certain considerations on well velocity measurements by Agip Mineraria in Italy and especially on the Po plain]: *Geophys. Prosp.*, v. 5, no. 2, p. 142-150, 1957.

The variation of interval velocity with depth in Quaternary formations was found to be 0.71 m per sec per m; in Miocene and Pliocene clays the variation is 0.62 m per sec per m; and in Miocene and Pliocene marls, 0.67 m per sec per m. These data have been successfully used in stratigraphic correlation and in exploration for stratigraphic traps.—*M. C. R.*

- 170-292. Van Sicken, De Witt C. Organic reefs of Pennsylvania age in Haskell County, Texas: *Geophysics*, v. 22, no. 3, p. 610-629, 1957.

The reflection seismograph was used to map a prominent organic reef in the Pennsylvanian system near Stamford in central northern Texas, and the results were checked by drilling. Since seismic wave velocity in the limestone comprising the reef is nearly twice that in the enclosing shale, distinctive reflections from beds below the base of the reef were mapped above their true position by an amount equal to almost half the reef limestone thickness. The false structure so mapped has been interpreted as showing the topography of the upper surface of the reef. As such, it is a mound 3 miles long and half as wide, with a corrected height of 1,000 feet and a central depression 300 feet deep resembling a present-day atoll. Numerous wells confirm the presence of this reef, but cast serious doubt upon the simple topographic interpretation of the seismic map. The atoll-like central depression appears to be an illusion, caused by the reef having a relatively high-velocity shell and a lower velocity center.

The Stamford reef is an exceptional development along a seemingly continuous

reef belt mapped similarly with the reflection seismograph for 25 miles. Where reef development is less extreme along this belt, and along two others of a closely related type, the reef trends show up as long, gently curving somewhat irregular seismic "highs" with many small contour closures. Detailed seismic interpretation of these reefs, and of the structure of underlying horizons which they obscure, must await improved geologic understanding of the reefs and of the subtle changes in lithology that modify seismic wave velocity.

Stamford reef illustrates also what a difference there can be between seismic closure, an obvious trap by subsurface mapping, and the location of a good oil field.—*Author's abstract*

- 170-293. Martin, Hans. Sprengung der beiden Türme der Ulrichskirche in Magdeburg am 5.5.1956 [Blowing up both towers of the Ulrichskirche in Magdeburg on April 5, 1956]: Freiburger Forschungshefte, C 32 Geophysik, p. 40-44, 1957.

The explosion of 370 kg that razed two war-damaged church towers in Magdeburg, Germany was recorded by horizontal and vertical vibration meters in a cellar about 70 m from the blast. A maximum velocity of 0.38 cm per sec was calculated for the shock waves, not much more than that (0.13 cm per sec) similarly measured at a distance of 90 m for a 3-ton pile driver falling 6.6 m.—*D. B. V.*

Dohr, Gerhard. On the detection by seismic reflection of very deep surfaces of discontinuity. See Geophys. Abs. 170-209.

- 170-294. Manfredini, Antonio. Captazione delle sorgenti subalvee del Torrente Farlà—Foglio 246 "Cittanova" (Italia meridionale) [Locating springs beneath the stream bed of the Torrente Farlà—Folio 246, "Cittanova" (central Italy)]: Servizio geol. Italia Boll., v. 78, fasc. 3, p. 481-482, 1956.

After electrical resistivity surveys were found ineffective because of lack of contrast between the alluvium and the underlying schist, seismic surveys were used to locate a "sill" of schist beneath the alluvium in the bed of the Torrente Farlà which brings ground water to the surface.—*D. B. V.*

STRENGTH AND PLASTICITY

- 170-295. Handin, John, and Hager, Rex V., Jr. Experimental deformation of sedimentary rocks under confining pressure: tests at room temperature on dry samples: Am. Assoc. Petroleum Geologists Bull., v. 41, no. 1, p. 1-50, 1957.

Triaxial compression tests were made on 23 dry rocks at room temperature under different confining pressures from 0 to 2,000 atmospheres. Stress-strain curves and curves of ultimate strength and ductility as functions of confining pressure are given for each rock. All rocks investigated showed small increases in elasticity and yield stress and large increases in ultimate strength under pressure. Most showed some increase of ductility. All fractured by shear on surfaces inclined at about 60° to 70° to the principal stress axis. The maximum shear stress-mean pressure curves for anhydrite, dolomite, and limestone are nearly linear, and the ultimate shear strength is about 0.7 to 0.8 the mean pressure on the average. Anhydrite and dolomite become moderately ductile and flow 10 percent at 2,000 atmospheres; the limestones can be deformed at least 30 percent at only 1,000 atmospheres. Porous, moderately well cemented

sandstones have shear strengths of about 0.6 mean pressure and large ductilities. Dense, well cemented sandstones, like quartzite, are brittle and their shear strength is about equal to the mean pressure. Shales differ most from sample to sample; ductilities range from nearly none to more than 30 percent at a mean pressure of only 1,000 kg per cm², and shear strengths are 0.6 or less of the mean pressure.—*M. C. R.*

- 170-296. Nishihara, Masao. Deformational characteristics of rocks under low stresses: *Doshisha Kogaku Kaishi*, v. 4, no. 3, p. 151-153, 1954.

To prove the assumption that the characteristics of rocks at the initial stage of deformation can be attributed to the inter-granular or inter-crystalline spaces, measurements were made of strains in a marble prism under compressive loading and unloading using a wire-resistance strain meter. The hysteresis curves obtained seemed to show that the packing of spaces takes place as in soils and powdered material. Thus, it was concluded that the deformational characteristics of some rocks under low stresses are similar to that of powdered materials.—*T. S. N.*

- 170-297. Handin, John. Higgs, D. V., Lewis, D. R., and Weyl, P. K. Effects of gamma radiation on the experimental deformation of calcite and certain rocks: *Geol. Soc. America Bull.*, v. 68, no. 9, p. 1203-1224, 1957.

Calcite single crystals, Yule marble, and certain other rocks were deformed dry at room temperature under constant confining pressures of 2,000 or 2,750 bars at a strain rate of 1 per cent per minute. Uniaxial compression and extension experiments were made; for the marble, parallel and normal to c_p fabric maximum; for the single crystals, parallel to c_p and normal to $m\{10\bar{1}0\}$. Yule marble exposed to 17 metaroentgens of gamma radiation before deformation turned from white to bright blue when deformed. Intensity of color varied with orientation and amount of strain. Irradiated single crystals changed from amber to ultramarine blue when the greatest principal stress paralleled c_p . No color change occurred when the least principal stress paralleled c_p . Irradiation resulted in small reductions in yield stress of most of the rocks, but not of the single crystals.

Petrographic studies of the single crystals revealed that established principal deformation mechanisms, twin gliding on $c\{01\bar{1}2\}$, and translation gliding on $r\{10\bar{1}1\}$, were still operative and confirmed that blue color was associated with translation gliding only. In Yule marble blue grains had deformed by translation, clear grains by twinning.

Thermoluminescence studies indicated that compression along c_p yielded a new peak in the glow curves (at 280°), not present in undeformed irradiated calcite. Extension along c_p increased the magnitude of the glow curve at about 240° but gave rise to no new peaks.—*Authors' abstract*

SUBMARINE GEOLOGY

- 170-298. Malaise, René. Oceanic bottom investigations and their bearings on geology: *Geol. Fören. Stockholm Förh.*, band 79, häfte 2, p. 195-224, 1957.

The concept of permanence of ocean basins is challenged. All submarine relief can be attributed to subaerial erosion, and Odhner's constriction theory "is the only one that can explain in a simple and natural way where the surplus of

ocean water was stored during the Pliocene, viz. in the extremely downbulged geosynclines the world over." Before the transgression at the beginning of the ice age the mid-Atlantic ridge was a narrow mountainous continent ("Atlantis") connected by land bridges with Europe, Africa, and America. The similarity of Quarternary artifacts of the Solutreans of western Europe and of Sandia man in America, regarded as an example of parallel development, is in reality evidence of a land connection. In an addendum Malaise also challenges the effectiveness of turbidity currents as the sculpturing agent of submarine canyons.—*D. B. V.*

- 170-299. Hamilton, Edwin L. Marine geology of the southern Hawaiian ridge: Geol. Soc. America Bull., v. 68, no. 8, p. 1011-1026, 1957.

Since 1950 six expeditions from the U. S. Navy Electronics Laboratory and Scripps Institution of Oceanography have added detailed information to the marine geology of the Hawaiian area. The Hawaiian Islands are peaks on a great ridge which is flanked, in the southern part, by the Hawaiian Deep beyond which is the Hawaiian Arch. The Deep is about 400 fathoms deeper on the east side. Echo-sounder profiles across the Arch on the east side indicate that it is faulted and more asymmetrical than at first supposed (it is steeper to the west) and has a width of about 200 nautical miles and a relief above the Deep of 300-500 fathoms. Downslope northeast of Oahu the normal structure is interrupted by linear volcanics along the same trends as the Honolulu series formed by Pleistocene and Recent volcanism on Oahu. The Hawaiian Deep and Arch continue to the northwest past Oahu. Off Molokai and Hawaii the Arch has been faulted. . . . The structure around the southern end of the Hawaiian Islands is due to the response of the earth's crust to the great load of the Hawaiian Ridge; this response is thought to be due mainly to elastic downbowing, but actual foundation failure cannot be excluded from consideration.—*Author's abstract*

- 170-300. Bourcart, J. Essai de carte sous-marine de l'ouest de la Corse [Attempt at submarine mapping west of Corsica]: Rev. Géographie phys. et Géologie dynamique, sér. 2, v. 1, fasc. 1, p. 31-35, 1957.

Preliminary results of a submarine survey along the west coast of Corsica show numerous canyons cutting the continental slope down to the horizontal surface of the clay at -2,700 m. The submarine valleys are prolongations of those on land and seem explicable only by subaerial erosion.—*D. B. V.*

VOLCANOLOGY

- 170-301. Piyp, B. I. Klyuchevskaya Sopka i eye izverzheniya v 1944-1945 g. i v proshlom [Klyuchevskaya Sopka and its eruptions during the years 1944-1945 as well as in the past]: Akad. Nauk SSSR Lab. vulkanol. Trudy, vypusk 11, p. 1-311, 1956.

A detailed discussion of the geologic features of Klyuchevskaya Sopka and nearby volcanoes, including the history of its eruptions since 1697. In its eruptive process the Klyuchevskaya Sopka has been found to be similar to Vesuvius. More than 200 references are given.—*S. T. V.*

- 170-302. Gregg, D. R. Eruption of Ngauruhoe, January 1956: New Zealand Jour. Sci. Technology, sec. B, v. 38, no. 7, p. 683-685, 1957.

After the eruptions of 1954-1955 (see Geophys. Abs. 167-288) the andesite volcano Ngauruhoe in New Zealand reverted to quiet steaming. During the first week of 1956 there were indications of increased steam discharge, masked by

bad weather; by January 11 there was a tremendous continuous discharge of steam from the crater accompanied by fumarolic activity on the upper slopes. A low roar could be heard from 2 miles away, and a red glow was reflected on clouds above the crater at night. Several explosions were heard on the afternoon of January 12. The first ash clouds were erupted early in the morning of January 13; some rocks were thrown out with the ash. Ash was emitted fairly continuously until January 22. Explosions were heard on February 10 and 11 when the crater was hidden by clouds; since then the volcano has steamed quietly.—*D. B. V.*

- 170-303. Roy, Sharat Kumar. Der heutige Zustand der Vulkane in Zentralamerika [The present condition of the volcanoes in Central America]: Neues Jahrb. Geologie u. Paläontologie Monatsh., Jahrg. 1957, Heft 4, p. 176-179.

In 1955-1956 only five volcanoes in the Central American volcanic region were active (Santiaguito, a side crater of Santa María, and Fuego, in Guatemala; Izalco in El Salvador; Concepción in Nicaragua; and Poás in Costa Rica); the rest of the 29 principal volcanoes were dormant. The habit of listing dormant volcanoes as active is misleading to the student of volcanological processes who travels far to see an "active" volcano and finds, for instance, only post-eruptive whiffs of gas.—*D. B. V.*

- 170-304. Roy, Sharat Kumar. Neue Gesichtspunkte zum 1917-Ausbruch des Vulkans Boquerón, El Salvador, Mittelamerika [New views on the 1917 eruption of the volcano Boquerón, El Salvador, Central America]: Neues Jahrb. Geologie u. Paläontologie Monatsh., Jahrg. 1957, Heft 6, p. 250-261.

An eruption of Boquerón in El Salvador began on June 7, 1917, and was preceded by strong earthquakes two hours before. The total evaporation of the crater lake containing 3 million m³ of water must have taken about 73.17×10^7 B. T. U. of heat. The cone Boqueroncito was built up in 8 days on the dry crater floor to a height of 40 m, but although great quantities of ash were erupted before its activity ceased in November of the same year, the cone did not grow further, as the material was blown far and wide.—*D. B. V.*

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